HOUSATONIC RIVER FLOOD CONTROL

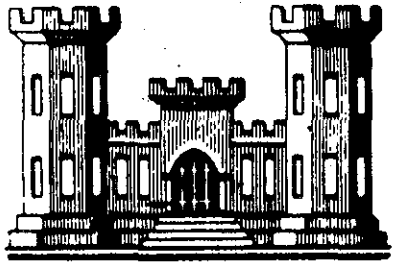
DERBY, CONN.

LOCAL PROTECTION

HOUSATONIC & NAUGATUCK RIVERS, CONNECTICUT

DESIGN MEMORANDUM NO.4

EMBANKMENTS, FOUNDATIONS AND CHANNEL IMPROVEMENTS



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

JULY 1968

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

IN REPLY REFER TO:

NEDED-F 3 July 1968

SUBJECT: Derby Local Protection Project, Housatonic and Naugatuck Rivers, Connecticut, Design Memorandum No. 4, Embankments, Foundations and Channel Improvements

Chief of Engineers
ATTN: ENGCW-E

There is submitted herewith, for review and approval, Design Memorandum No. 4, Embankments, Foundations and Channel Improvements for Derby Local Protection Project, Housatonic River Basin, Connecticut, in accordance with EM 1110-2-1150.

FOR THE DIVISION ENGINEER:

John Wm Leslie

1 Incl
as (10 cys)

JOHN Wm. LESLIE
Chief, Engineering Division

DESIGN MEMORANDA INDEX

No.	Title	Date Submitted	Date Approved
1	Hydrology and Interior Drainage	10 Jan. 1968	14 March 1968
2	General (Including Site Geology and Concrete Materials)	28 Feb. 1968	24 April 1968
3	Hydraulic Analysis	18 April 1968	4 June 1968
4	Embankments, Foundations and Channel Improvements		
5	Structures and Pumping Station		

DERBY LOCAL PROTECTION PROJECT

HOUSATONIC AND NAUGATUCK RIVER

HOUSATONIC RIVER BASIN

CONNECTICUT

DESIGN MEMORANDUM NO. 4

EMBANKMENTS, FOUNDATIONS AND CHANNEL IMPROVEMENTS

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DEPARTMENT OF THE ARMY

New England Division, Corps of Engineers

DERBY LOCAL PROTECTION PROJECT

NAUGATUCK AND HOUSATONIC RIVERS

CONNECTICUT

DESIGN MEMORANDUM NO. 4

EMBANKMENT, FOUNDATIONS AND CHANNEL IMPROVEMENTS

A. INTRODUCTION

1. Location and Description of Project - The Derby Local Protection Project is located at the confluence of the Housatonic and Naugatuck Rivers in the City of Derby, New Haven County, Connecticut. It is a flood control project consisting of earth fill dikes and concrete flood walls along the right bank of the Naugatuck River and the left bank of the Housatonic River. The dike along the Naugatuck River will be contiguous with that constructed for the Ansonia-Derby Local Protection Project. The locations, arrangements and details of the structures are shown on Plates 4-1 and 4-3 through 4-6.

2. General Notes - Programs of subsurface investigations and soils engineering studies were undertaken for the design of the Derby Local Protection Project. The subsurface investigations included geological studies, subsurface explorations and laboratory test programs carried out to determine the distribution and characteristics of foundation and embankment materials and to determine soil conditions relevant to excavation operations and the design and construction of the embankments and concrete structures. Soils engineering studies, based on the data obtained from the subsurface explorations, were conducted to develop

safe and economical earthwork and foundation designs and construction methods.

3. Elevations - All elevations mentioned in this report are in reference to mean sea level.

B. SUBSURFACE INVESTIGATIONS

4. Geological Studies - The results of the geological studies are presented in approved Design Memorandum No. 2, General Design (including Site Geology and Concrete Materials).

5. Subsurface Explorations - Subsurface explorations were laid out and completed in conformance with current criteria and practices as described in Corps of Engineers Manuals EM 1110-2-1801, "Geological Investigations" and EM 1110-2-1803, "Subsurface Investigations - Soils." Most of these explorations were drive sample borings made with continuous sampling using a 5-foot solid sample spoon. Split sample spoons were used in four of the borings where less disturbed samples were desired to determine in detail the distribution and extent of thin layers of organic matter. Five test trenches were excavated with a small backhoe to determine the character and extent of the existing rockfill portion of a highway embankment to which one of the dikes tied in. Five test pits were also excavated by machine to determine in detail the characteristics and distribution of surficial foundation materials in the dike foundations in areas where information from borings would not be sufficiently definitive for design purposes. The subsurface exploration program is considered adequate for design and construction control purposes. The locations of the explorations are shown on Plates Nos. 4-2 through 4-6.

6. Laboratory Tests - All laboratory tests were performed in accordance with the procedures described in Corps of Engineers Manual EM 1110-2-1906, "Laboratory Soils Testing." All soil samples were visually classified in accordance with the United Soil Classification System. Grain size analyses and Atterberg Limit determinations were performed on selected samples to confirm the visual classifications and to provide more precise data where required. Natural water contents were determined for selected samples of fine grained soils.

7. Presentation of Data - The results of the subsurface investigations, except for the geological sections, are presented in this memorandum. The results of the laboratory tests are summarized in Appendix A. Selected laboratory test data are shown on Plate 4-13. Soil profiles for the project foundations, based on engineering soil reports, are shown on Plates 4-7 through 4-12. These soil reports were prepared for all pertinent explorations by the design soils engineer with the aid of the laboratory test data and the assistance of an experienced soils classifier. These reports include descriptions of the soils and soil strata based on the engineer's examination of the samples and his interpretation of the test results and the exploration data. These descriptions cover the state or consistency of a soil, estimated or measured percentages of soil components, color, stratification, presence of foreign matter, geological names, and other information of significance to the determination of the characteristics of a soil for design and construction purposes.

C. CHARACTERISTICS OF DIKE AND WALL FOUNDATION MATERIALS

8. Distribution and Description of Materials

a. Naugatuck Dike

(1) General - The Naugatuck Dike will be constructed in the flood plain of a river which followed a braided stream pattern until its present channel was dredged in 1956. The dike foundation area consequently includes old river channels which have been filled with a variety of materials either by natural processes or artificially. Since 1956, this area has been used for the processing and storage of concrete and asphalt aggregates. Numerous large stockpiles of processed and unprocessed materials presently cover those portions of the area not occupied by the processing plants, roads, settling basins and process water supply ponds.

(2) Projected Topographic Conditions - With the rapid construction and removal of the stockpiles and the excavation and filling in of the settling basins, the topographic conditions for the Naugatuck Dike are in a fluid condition and are expected to remain so until the property has been acquired for construction. The present owners are expected to remove the stockpiles as personal property prior to construction of the dike. For purposes of design, it has been assumed that at the start of construction the dike foundation surface will be at Elev. 5.0 from Sta. 0+00 to Sta. 25+00 and will rise gradually from Elev. 5.0 at Sta. 25+00 to Elev. 30.0 at Sta. 30+00. It is unlikely that the present owners will fill in any ponds or settling basins existing at the time the property is acquired. It is therefore planned to resurvey this area immediately prior to construction to provide data for any necessary design changes.

(3) Subsurface Water - Subsurface water levels in the dike foundation area fluctuate with the level of the adjacent river. The river level varies with the tides and flow conditions but generally varies between Elev. 0 and Elev. 5.

(4) Foundation Zones - The foundation soils for the Naugatuck Dike occur in four fairly distinct zones which are designated in order of depth as Zones I, II, III and IV. Zone I is a relatively thin surficial zone of variable soil types including natural and artificial channel fillings. Zone II is a zone of gravelly soils of varying thickness. Zone III is a zone of highly stratified fine-grained non-plastic soils. Zone IV is the lowest zone and consists of variable gravelly silty sand. In general, these zones are horizontally continuous. In places, however, Zone I and, to a lesser extent, Zone II have been interrupted by the excavation of settling basins which are being filled with fines from the aggregate washing operations. These washed fines consist principally of loose uniform sandy silt (ML).

(5) Stations 0+00 to 10+00 - In this reach of the Naugatuck Dike, Zone I is from 1 to 5 feet thick and consists of brown, moderately compact, variable sands and gravels of the SP, SP-SM, SM, GP-GM and GM classes. Silt contents of these soils range from 5 to 30 percent of the components passing the No. 4 Sieve. Gravel contents of the sands are generally less than 30 percent. Some of the materials contain minor amounts of debris in the form of wood, cinders, lumps of coal, pieces of rubber tires and similar matter. Zone II in this reach is from 8 to 15 feet thick with its top surface above Elev. 0.0 and consists of brown and gray-brown, moderately compact cobbly, sandy gravels (GP and GW) and gravelly sand (SP) with occasional silty phases of the

SP-SM and GM classes. For most of the sands and gravels, silt contents are less than 10 percent of the components passing the No. 4 Sieve although in the occasional silty phases they may be as high as 15 percent. Zone III in this reach is generally over 25 feet thick and consists of stratified brown, gray and gray-brown, moderately compact, non-plastic sandy silt (ML) and silty fine sand (SM) with an included zone of silty medium to fine sands, (SP, SP-SM and SM). Silt contents of the silty fine sands range from 15 to 50 percent while those of the silty medium to fine sands range from 3 to 15 percent. The sandy silts contain from 15 to 50 percent fine sand. Zone IV was encountered in the explorations only in this reach. The top surface of this zone is below Elev. minus 20.0. Soils in this zone consist of brown, moderately compact, gravelly silty sands (SP and SP-SM) with gravel contents ranging from 15 to 45 percent and silt contents ranging from 5 to 20 percent of the components passing the No. 4 Sieve.

(6) Stations 10+00 to 24+00 - In this reach of the Naugatuck Dike, Zone I is generally about 5 feet thick and of the same composition as in the previously described reach. Between Stations 16+00 and 24+00 on the landside, however, this zone also includes numerous scattered pockets and layers of silty fine and medium to fine sands (SM), sandy silt (ML) and sandy organic silt (OL). Zone II in this reach is essentially of the same thickness and composition as in the previously described reach. Zone III in this reach differs from that in the previously described reach only in the absence of the included zone of medium to fine sand.

(7) Stations 24+00 to 31+00 - The portion of this reach of the Naugatuck Dike from approximately Stations 28+00 to 31+00 was once used as a city dump. The trash fill in this dump overlies Zone I in this portion of the reach and includes ashes, cinders, wood, coal and similar matter. The trash fill will be removed from the foundation of the dike prior to its construction. Zone I extends from the ground surface or the bottom of the old dump down to about Elev. 0.0. Zone I soils in this reach consist of brown, dark brown and gray, loose to moderately compact, silty fine and medium to fine sands (SM) and sandy silt (ML) with thin layers and pockets of sandy organic silt (OL). This zone also contains minor amounts of roots, wood, decayed vegetation, coal and asphalt fragments. Zone II in this reach is essentially of the same composition as in the previously described reaches but is of considerably greater thickness extending as low as Elev. minus 30.0 near Station 29+00.

b. Housatonic Floodwall and Dike.

(1) General - The Housatonic Floodwall and Dike will be built principally in the flood plain of a river which followed a braided stream pattern until its channel was eventually stabilized by construction activities of the past century. The floodwall and dike foundation areas consequently include old river channels which have been filled with a variety of materials.

(2) Subsurface Water - Subsurface water levels in the flood wall and dike foundation areas fluctuate with the level of the adjacent river. The river level varies with the tides and flow conditions but generally varies between Elev. 0 and Elev. 5.

(3) Foundation Zones - The foundation materials for the Housatonic Floodwall and Dike occur in three fairly distinct zones designated in order of depth as Zones I-H, II-H, and III-H. Zone I-H is a surficial zone of variable materials ranging from trash to granular fill materials and including natural soils in some reaches. Zone II-H is a zone of gravelly soils. Zone III-H is a zone of soils of significantly finer gradation than those in Zone II-H.

(4) Stations 1+00 to 4+50 (Floodwall).- Zone I-H in the foundation area of the Housatonic Floodwall is from 17 to 25 feet thick extending from the present ground surface down to about Elev. 0.0. Materials in this zone are principally granular fill materials consisting of brown and light brown, loose to moderately compact, gravelly silty sand (SP-SM) with occasional layers of gravelly silty sand (SM) and medium to fine sand (SP). These materials are generally moderately compact below Elev. 5+0. These materials generally contain minor amounts of ashes, cinders, concrete fragments and similar foreign matter. The quantity of such foreign matter is significantly higher near the ground surface. In the vicinity of Sta. 4+50, these materials overlie layers of dark gray, loose to moderately compact, sandy silt (ML), sandy organic silt (OL) and silty sand (SM) between Elev. minus 2.0 and plus 4.0. In the same area a 3-foot layer of soft ashes was encountered between Elev. 4.0 and 7.0. This particular area will be occupied by the I-wall connection between the floodwall and dike. These layers will be removed as part of the foundation preparation for the wrap-around portion of the dike. Zone II-H in this reach is from 13 to 15 feet thick and consists of brown and gray-brown, loose to moderately compact, cobbly, sandy gravels (GP and GW) and gravelly

sand (SP) with layers of silty sandy gravel (GP-GM) and gravelly silty sand (SP-SM) and occasional siltier phases in the GM and SM classes. For the most part, silt contents are less than 10 percent of the components passing the No. 4 Sieve although in the siltier phases they may go as high as 25 percent. Gravel contents of the sands range from 5 to 40 percent. Zone III-H in this reach is generally over 10 feet in thickness and consists of brown, gray-brown and gray, moderately compact to compact, gravelly silty sands (SP, SW-SM, SP-SM and SM) and silty sands (SW-SM and SP-SM) with an occasional layer of silty sandy gravel (GP-GM). Gravel contents are generally less than 30 percent. Silt contents generally range from 5 to 25 percent of the components passing the No. 4 Sieve.

(5) Stations 4+50 to 12+00 (Dike) - A large part of the foundation area for the Housatonic Dike in this reach is occupied by a cove of the river. In this cove, Zone I-H is present only intermittently and generally consists of one or two feet of loose silt, mud and debris. Inland from the cove, however, Zone I-H is from 3 to 20 feet thick extending from the present ground surface down to about Elev. minus 2.0, and includes an old urban dump. Materials in this portion of the zone consist of loose mixtures of coal, ashes, cinders, brick, wood and other trash fill materials occasionally mixed with sand and silt. Zones II-H and III-H in this reach are essentially the same with respect to thickness and composition as in the previously described reach.

(6) Stations 12+00 to 16+00 (Dike) - Zone I-H in this reach of the Housatonic Dike is generally from 5 to 9 feet thick extending from the present ground surface down to about Elev. 0.0. On the riverside of the alignment, however, this zone is somewhat deeper extending as low as Elev. minus 9.0. Soils in this zone consist of stratified dark brown, brown and light brown, loose, non-plastic sandy silt (ML), silty fine sands (SP-SM and SM), medium to fine sand (SP) and sand (SP). Numerous small roots are scattered throughout this zone and its upper portion contains minor amounts of slag and asphalt, brick and metal fragments. Layer thicknesses range from about 1/4 inch to 2 feet. Zone II-H in this reach is of the same thickness and composition as in the previously described reaches. Zone III-H is generally over 30 feet thick lying below Elev. minus 20.0. Soils in this zone consist of brown, light brown and gray-brown, moderately compact to compact, silty medium to fine and fine sands (SM and SP-SM), medium to fine sand (SP), and non-plastic sandy silt (ML).

(7) Stations 16+00 to 21+00 (Dike) - Zone I-H in this reach of the Housatonic Dike ranges from 5 to 18 feet in thickness extending at the most from the present ground surface down to Elev. minus 10 on the landside and to Elev. minus 8 on the riverside. The composition of this zone is much the same as in the previously described reach except for the presence in this reach of layers and lenses of black, loose, muck (Pt). These are more prevalent on the landside of this reach, occurring between Elev. plus 2 and minus 12. The layers and

lenses are generally less than 2 inches thick, but in one boring a zone was encountered between Elev. minus 6.1 and minus 9.2, consisting of over 50 percent muck with thin sand layers. On the riverside of this reach, there are very few muck layers and lenses occurring intermittently between Elev. plus 2 and minus 8. Three split spoon borings were made in this portion of the reach and muck was encountered in only two of them. In one of these, only a single 1/2 to 1-inch layer was encountered. In the other, a few 1/8 to 1/2-inch layers were encountered between Elev. plus 1.7 and plus 0.2, a zone of alternating layers of muck and silty medium to fine sand was encountered between Elev. plus 0.2 and minus 0.9 and single 1/2-inch layers were encountered at Elev. minus 5.8 and minus 7.8. Zones II-H and III-H are essentially the same in thickness and composition as in the previously described reach.

9. Shear Strength - No samples of foundation materials for this project were tested for shear strength. The shear strength parameters tabulated below have been estimated on the basis of visual examination of the samples and their grain size distribution curves, data from the subsurface exploration logs and experience with similar materials. These parameters are considered to be applicable for all conditions considered within the anticipated ranges of applied stresses.

Foundation Zone (Naugatuck Dike)	Estimated Shear Strength Parameters	
	ϕ	c
Zone I - Sta. 0+00 to 24+00	30°	0
Sta. 24+00 to 30+00	25°	0
Zone II	30°	0
Zone III	25°	0
Zone IV	30°	0

Foundation Zone		Estimated Shear Strength Parameters	
(Housatonic Floodwall & Dike)		ϕ	c
Zone I-H -	Sta. 1+00 to 4+50	30°	0
	Sta. 4+50 to 12+00	Not applicable (to be removed)	
	Sta. 12+00 to 16+00	25°	0
	Sta. 16+00 to 21+00	25°	0
	Sta. 16+00 to 21+00	0	500 p.s.f.*
Zone II-H		30°	0
Zone III-H		30°	0

*Applicable only to possibly continuous horizontal layer of muck (Pt)

10. Permeability - No permeability tests were performed on samples of foundation materials for this project. The ranges of coefficients of vertical permeability tabulated below have been estimated on the basis of visual examinations of the samples and their grain size distribution curves and experience with similar materials. It is estimated that ratios of horizontal to vertical permeabilities will range from 9 to 16. As indicated below, the dike foundation materials in Zones I and I-H are significantly less pervious than those in the underlying Zones II and II-H.

Foundation Zone		K_v 10^{-4} cm/sec
(Naugatuck Dike)		
Zone I -	Sta. 0+00 to 24+00	5 to 100
	Sta. 24+00 to 30+00	1 to 10
Zone II		100 to 500
Zone III	Sta. 0+00 to 10+00	1 to 150
	Sta. 10+00 to 30+00	1 to 20
(Housatonic Floodwall and Dike)		
Zone I-H	Sta. 1+00 to 4+50	1 to 200
	Sta. 12+00 to 21+00	1 to 50
Zone II-H		50 to 400
Zone III-H	Sta. 1+00 to 12+00	1 to 100
	Sta. 12+00 to 21+00	1 to 50

11. Consolidation - Consolidation tests were not performed on samples of foundation materials for this project. With the exception of the trash fill materials in the old dumps and the organic silt and muck layers, the dike foundation materials are of types exhibiting low compressibility. All trash fill materials will be removed from the foundation areas of the dikes. While the materials in the organic silt and muck layers in certain dike reaches are compressible, the layers are relatively thin and surrounded by more pervious soils. Settlements due to consolidation in these layers consequently are expected to occur principally during embankment construction. The foundation materials for the floodwall are of types exhibiting low compressibility and no significant floodwall settlements are anticipated.

D. DISTRIBUTION AND DESCRIPTION OF MATERIALS FROM REQUIRED EXCAVATIONS

12. General - The major excavations for this project are those for the floodwall, the dike foundation drains, the riverside toes of the stone protection layers, the removal of trash fill and the Naugatuck Channel Improvement. All suitable materials from these and other excavations will be utilized to the extent practicable in the permanent work. It has been decided to use these materials in random fill zones in the embankments and for certain backfill zones for the floodwall and concrete structures because of the great variation in soil types involved and their erratic distribution. A portion of the materials from the required excavation unsuitable for use in the random fill zones will be utilized to the extent possible as dumped waste fill material.

13. Naugatuck Dike Excavations

a. Foundation Drain - The excavations for the foundation drain for the Naugatuck Dike will be made in highly variable deposits of gravelly silty sands (SP-SM and SM), silty fine sand (SM), sand (SP) and sandy gravel (GP) portions of which contain very minor amounts of coal, wood and similar debris. These deposits also include occasional deposits of non-plastic sandy silt (ML) and a few limited thin zones of buried topsoil consisting of sandy organic silt (OL).

Although the mixing of various layers during excavation will result in the excavated material being more homogeneous, it will still be variable with silt contents ranging from 5 to 30 percent of the component passing the No. 4 Sieve and gravel contents ranging from 5 to over 50 percent. In certain reaches, particularly at the settling basins, the excavated material may consist entirely of sandy silt (ML). The foundation drain excavations will be done in the dry and no problems involving excessive water contents are anticipated for the bulk of the excavated material.

b. Stone Protection Layers - The excavations for the riverside toes of the stone protection layers along the Naugatuck River will be made in deposits similar to those in which the foundation drain will be excavated. These excavations, however, will be done partially in the wet and it is expected that drying back of some excavated material will be necessary.

c. Naugatuck Channel Improvement - The upper portion of the excavations for the Naugatuck Channel Improvement will be made in an old city dump. The materials from this portion of the excavation will consist of cinders, ashes and other debris and will be spoiled. The lower portion of these excavations will be in deposits similar to those in which the foundation drain will be excavated except that they contain fewer gravel layers.

d. Dike Foundation- The excavations in the foundation of the Naugatuck Dike between Sta. 28+00 and 31+00 will be made for the removal of an old city dump. Materials from these excavations will be spoiled.

14. Housatonic Floodwall and Dike

a. Floodwall- Excavations for the Housatonic Floodwall will be made in existing fills consisting principally of gravelly silty sands (SP, SP-SM and SM) and medium to fine sand (SP) with occasional layers of non-plastic sandy silt (ML) and occasional limited zones of sandy organic silt (OL) and minor amounts of cinders, ashes and similar matter. There are a few scattered layers of ashes in these fills which are large enough to be separated and spoiled. The random fill material from these excavations will be variable with silt contents ranging from 5 to 25 percent of the component passing the No. 4 Sieve and gravel contents ranging from 15 to over 50 percent. The minor quantities of sandy silt, sandy organic silt, cinders and ashes will be dispersed through the excavated material to such an extent that their presence will not be of significance.

b. Dike Foundation - The excavations in the foundation of the Housatonic Dike between Sta. 4+50 and 12+00 will be made for the removal of an old dump containing cinders, ashes, brick, wood and other trash, and of river bottom deposits of loose silt, mud and debris. Materials from these excavations will be spoiled.

c. Foundation Drain - Excavations for the foundation drain for the Housatonic Dike between Sta. 12+00 and 21+00 will be made principally in a stratified deposit of non-plastic sandy silt (ML), silty fine sands (SP-SM and SM) and medium to fine and coarse to fine sands (SP) portions of which contain minor amounts of slag, metal, asphalt and brick fragments. Random fill material from these excavations will contain little or no gravel sizes and from 10 to 50 percent silt. These excavations will be done in the dry and no problems involving excessively high water contents are anticipated for the bulk of the excavated material.

d. Stone Protection Layers - The excavations for the riverside toe of the stone protection layers along the Housatonic River will be made in deposits of sandy gravel and gravelly sand with occasional silty phases and with a few limited surficial zones of sandy organic silt. Random fill material from these excavations will consist principally of silty sandy gravel (GP and GP-GM) with sand contents of 30 to 50 percent and gravelly silty sand (SP and SP-SM) with gravel contents of from 40 to 50 percent. The silt content will generally be less than 15 percent of the component passing the No. 4 Sieve. Since these excavations will be done partially in the wet, it is expected that drying back of some excavated material will be necessary.

E. CHARACTERISTICS OF EMBANKMENT MATERIALS

15. General - The quantity of suitable embankment material available from the required excavations for the project will be only a small part of the total quantity of materials needed to complete the embankments. Reference is made to approved Design Memorandum No. 2, "General Design" for a discussion of off-site sources of embankment materials. In view of the relatively high cost of developing government-furnished borrow areas and the complications involved in acquiring land for borrow areas outside the town of Derby, it has been decided to have the contractor furnish all embankment materials other than those available from the required excavations.

16. Filter Design - The gradation requirements for sand, gravel, processed gravel and filter sand fill materials and for gravel bedding materials have been established in accordance with the filter design criteria set forth in Engineering Manual for Civil Works Construction, EM 1110-2-1901, "Seepage Control." Typical filter design studies are shown on Plates Nos. 4 - 17 through 4 - 19.

17. Random Fill - The suitable embankment material from the required excavation will include a wide range of soils - from clean sandy gravels to silty fine sands with a minor quantity of sandy silts. In view of the variability of the material and the impracticability of separating the various soil types during construction, it is planned

to use the material in random fill zones in the embankments. Random fill material will not contain significant quantities of cinders, ashes, topsoil and similar matter and shall be free of stumps and large pieces of debris. For design purposes, the densities, permeability coefficients and shear strength parameters selected for impervious fill material have been used for the random fill material.

18. Impervious Fill - Impervious fill material will be furnished by the contractor and will consist of approved, natural, reasonably well graded, gravelly silty sand. The gradation of the material will be required to be such that from 60 to 95 percent of the component passing the 3-inch Sieve will pass the No. 4 Sieve and from 25 to 45 percent of the component passing the No. 4 Sieve will pass the No. 200 Sieve. It is estimated that compacted impervious fill material will have an average coefficient of permeability of less than 1×10^{-4} cm/sec and will develop shear strength parameters in excess of a ϕ = 30 degrees, c = 0.2 TSF envelope within the anticipated applied stress range for all conditions considered. Experience with similar materials on other projects indicates that placement moisture content can be maintained within 2 percentage points of optimum with moderate moisture control and that in-place compacted dry densities will be on the order of 120 p.c.f.

19. Sand Fill - Sand fill material will consist of either filter sand fill material as specified in Paragraph 22 or approved bank-run reasonably well graded gravelly sand furnished by the contractor. The bank-run material will be required to meet the following gradation limits:

Sieve Size (U.S. Standard)	Percent Passing by dry weight
3-inch	100
No. 4	75-95
No. 10	55-85
No. 50	10-40
No. 200	0-8

(In addition, not more than 3 percent, by dry weight, shall be finer than 0.01 mm). It is estimated that compacted sand fill material will have an average coefficient of permeability exceeding 100×10^{-4} cm/sec and will develop an angle of internal friction of at least 30 degrees.

20. Gravel Fill - Gravel fill will consist of approved contractor furnished material reasonably well graded within the following limits:

Sieve Size (U.S. Standard)	Percent Passing by dry weight
6-inch	100
1-inch	50-80
No. 4	30-60
No. 16	15-40
No. 200	0-5

(In addition, not more than 3 percent, by dry weight, of the component passing the No. 4 Sieve shall be finer than 0.01 mm). It is estimated that compacted gravel fill material will have an average coefficient of permeability exceeding 200×10^{-4} cm/sec and will develop an angle of internal friction of at least 30 degrees.

21. Processed Gravel Fill - Processed gravel fill will consist of contractor furnished material meeting all Corps of Engineers specification requirements for coarse concrete aggregate in the No. 4 to 3/4 inch size range. It is estimated that compacted processed gravel fill material will have an average coefficient of permeability on the order of $10{,}000 \times 10^{-4}$ cm/sec.

22. Filter Sand Fill - Filter sand fill will consist of contractor furnished material meeting the Corps of Engineers gradation specification for fine concrete aggregate. It is estimated that compacted filter sand fill material will have an average coefficient of permeability in excess of 500×10^{-4} cm/sec.

23. Class I Gravel Bedding - Class I gravel bedding will consist of approved contractor furnished material reasonably well graded within the following limits:

Sieve Size (U.S. Standard)	Percent Passing by dry weight
6-inch	100
1-inch	50-85
No. 4	30-70
No. 16	15-40
No. 200	0-5

(In addition, not more than 3 percent, by dry weight, of the component passing the No. 4 Sieve shall be finer than 0.01 mm).

24. Class II Gravel Bedding - Class II gravel bedding will consist of approved contractor furnished material reasonably well graded within the following limits:

Sieve Size (U.S. Standard)	Percent Passing by dry weight
6-inch	100
4-inch	85-100
2-inch	65-85
3/4-inch	50-70
No. 4	30-50
No. 40	5-20
No. 200	0-8

(In addition, not more than 3 percent, by dry weight, of the component passing the No. 4 Sieve shall be finer than 0.01 mm).

F. DESIGN OF DIKES

25. Criteria - Current design criteria as set forth in the pertinent sections of the Engineering Manual for Civil Works Construction No. 1110-2-2300, "Earth Embankments" and the regulations and bulletins referred to therein have been followed in the design of the dikes for this project.

26. Materials for Embankment Construction

a. Materials from Required Excavations - It is estimated that there will be about 287,000 cubic yards of required excavations for this project. Of the materials from these excavations, about 82,000 cubic yards will be suitable for use in the random fill zones of the dikes and for certain backfills around concrete structures. The remaining 105,000 cubic yards of material will consist in large part of cinders, ashes, trash fill, and stripping material. All suitable material from the required excavations will be used either in the embankments or in certain backfill zones for the concrete structures.

b. Materials Furnished by the Contractor - All dike materials other than random fill material will be furnished by the contractor from off-site sources.

c. Materials Usage - A chart showing the proposed utilization of materials from the required excavations and of materials furnished by the contractor is shown on Plates 4-25. The quantities shown are subject to change as more detailed quantity estimates are developed during the preparation of plans and specifications for the project.

27. Selection of Dike Sections - The sections for various reaches of the dikes developed as a result of design studies are shown on Plates 4-20 and 4-21. The selection of the sections was influenced by the foundation conditions, the availability and characteristics of embankment materials, seepage control requirements, stream erosion and construction considerations. In general, the embankments will consist of a large zone of compacted impervious fill, a smaller zone of compacted random fill, a landside zone of compacted sand fill and a landside toe drain of processed gravel fill or compacted sand fill. The embankment will be protected by layers of rock protection and gravel bedding on the riverside slopes and by seeded topsoil on the landside slopes except for limited rock protection layers at the toes.

28. Seepage Control

a. Seepage Through Dike - Seepage through the dikes will be controlled through the arrangement, sizes and differences in permeabilities between the impervious fill zone and those of the landside sand fill, processed gravel fill and gravel fill zones.

b. Foundation Seepage

(1) General - In view of the relatively high hydraulic heads anticipated and the presence of a pervious foundation zone overlain by less pervious material, considerable attention was given to the design of the foundation seepage control features for this project. No continuous foundation zone of suitable impervious soil exists in the dike foundation to which an impervious foundation cut-off could be extended. Foundation seepage control for the dikes therefore has been based on providing landside drainage facilities of sufficient capacity to prevent the development of detrimental seepage pressures beneath the less pervious upper soil strata. Where practicable, these facilities consist of foundation toe drains extending into the pervious foundation strata. In reaches where depths to the pervious strata are considered excessive, relief wells will be used.

(2) Naugatuck Dike (Sta. 0+00 to Sta. 26+50) - In this reach of the Naugatuck Dike the top of the pervious foundation zone (Zone II) is between Elev. 5.0 and Elev. minus 2.0. With a bottom elevation of minus 5.0, the foundation toe drain will extend into this pervious zone by two or three feet. The drain itself will consist principally of compacted processed gravel with layers of filter sand fill.

(3) Naugatuck Dike (Sta. 26+50 to Sta. 30+00) - The pervious foundation zone in this reach of the Naugatuck Dike is too far below the ground surface to be reached economically with a foundation toe drain. In the portion of this reach where foundation seepage control is required (between Sta. 26+50 and 28+00) it will be provided through the installation of four relief wells at 50-foot spacing. These will be 6-inch wells placed in 18-inch diameter holes with surrounding filters. Well depths will range from about 35 to 45 feet. Well screen lengths will be 20 feet which is expected to provide practically complete penetration of the pervious zone. Modification to this plan will be made if topographic conditions at the start of construction differ significantly from those expected.

(4) Housatonic Dike Sta. 4+00 to Sta. 11+50) - The excavations for the removal of the trash fill from the dike foundation in this reach will uncover most of the pervious foundation zone (Zone II-H). The foundation toe drain will extend to the bottom of the excavation with provision for further extension if necessary to uncover the pervious strata. The drain itself will consist of compacted sand fill with a perforated pipe drain and processed gravel filter. The pipe drain is included to prevent emergence of seepage in the ground surface in the developed area behind the dike.

(5) Housatonic Dike (Sta. 12+20 to Sta. 16+50) - In this reach of the Housatonic Dike, the top of the pervious foundation zone is between Elev. minus 1 and Elev. minus 5. With its bottom elevation set at minus 5.0, the foundation toe drain will extend to or into the pervious strata. This drain will consist of processed gravel fill and filter sand fill with a perforated pipe drain.

(6) Housatonic Dike (Sta. 16+50 to Sta. 20+00) - The pervious foundation zone in this reach of the Housatonic Dike is too far below the ground surface to be reached economically with a foundation toe drain. Foundation seepage control will be provided through the installation of relief wells at 50-foot spacing. These will be 6-inch wells placed in 18-inch diameter holes with surrounding filters. The wells will be about 35 feet deep with 15-foot screen lengths. It is expected that complete penetration of the pervious zone will be obtained for all of the wells.

c. Contacts with Concrete Structures - At the junctions of embankments and concrete structures, impervious fill material will be carefully compacted by special methods to produce a tight contact with the structure and a high fill density in the zone within which rolling compaction equipment cannot or should not operate. At the junction of the concrete floodwall and the Housatonic Dike, the normal

T-wall - I-wall type connection will be used. I-wall connections will also be used between the Housatonic Dike and Railroad Gate No. 3.

d. Blanketing of Existing Highway Embankment - At its downstream end, the Housatonic Dike will tie-in to the existing embankment for Connecticut State Highway Route No. 8. It has been determined that this embankment includes a large rockfill toe which extends along both sides of the embankment and across its south end. The rockfill is highly pervious and extremely high quantities of seepage could pass through it around the end of the Housatonic Dike. To prevent this, an impervious fill blanket will be constructed on the outer slope of the rockfill along the south end and east side of the embankment. The blanket will be contiguous with the impervious fill section of the dike at one end and will tie in to the earth backfill for the wingwall of a railroad underpass at the other end. Filter layers of gravel bedding and stone protection will be placed between the impervious fill blanket and the rockfill. A portion of the rockfill on the landside of the dike (the west side of the highway embankment) will be exposed by stripping and blanketed with stone protection material so as to control the emergence of any seepage that might enter the rockfill despite the impervious blanket.

29. Embankment Stability

a. General - The riverside portion of the Housatonic Dike at Station 18+00 was selected for stability analysis as being the section combining a near maximum embankment height with significant foundation layers of low shear strength. The section was analysed for stability against shear failure by the wedge method for the end of construction and sudden drawdown conditions assuming a weak foundation layer at Elev. minus 10. In making these analyses, it was assumed that the riverbed had scoured to the level of the bottom of the stone protection toe.

b. Selection of Design Values - The design unit weights and shear strength parameters have been selected on the basis of experience with similar materials on other projects and are as tabulated below:

	Unit Weight, p.c.f.				Shear Strength	
Material	Sat	Moist	Dry	Sub	ϕ	C
Stone Protection	140	-	120	78	35°	0
Gravel Bedding and Gravel Fill	145	140	130	83	30°	0
Compacted Impervious and Random Fill	140	130	120	78	30°	400 psf
Compacted Sand Fill	145	140	130	83	30°	0
Foundation Silty Fine Sand	120	100	90	58	25°	0
Failure Plane	-	-	-	-	0	500 psf

c. Results of Stability Analyses - The results of the stability analyses are summarized on Plate 4 - 22 and the analyses for the critical sets of planes are shown on Plates 4 - 23 and 4 - 24. The minimum factors of safety are tabulated below. On the basis of the results of these analyses, it is considered that the selected embankment sections are safe against shear failure.

Condition Analyzed	Minimum Factor of Safety
Sudden Drawdown	1.04
End of Construction	1.49

30. Settlements - For the most part, the dike foundation soils are of low compressibility and no significant settlements are anticipated. In the reach of the Housatonic Dike between Sta. 16+00 and 21+00, however, there are areas on the landside of the dike in which the foundation includes layers and lenses of compressible organic soils. These layers and lenses are generally thin and interbedded with more pervious soils. It is expected that settlements due to the presence of these organic soils will occur almost entirely during construction and that no significant post-construction settlements will take place. The trash fill materials in the old dumps will be removed prior to construction of the dikes.

31. Construction Considerations.

a. Dewatering Construction Areas - All areas in which compacted embankment fills are to be constructed will be dewatered. Along portions of the riverside toe of the Housatonic Dike, there will be a

gravel fill zone which will serve as a permanent cofferdam. The lower portion of this zone will be dumped in about 5 feet of water while the upper 3 feet of the zone will be compacted. The dumped gravel fill will be placed by end-dumping and pushing to minimize segregation. The excavations for the foundation toe drains for the dikes will be dewatered.

b. Rate of Construction - In general, the dikes will be constructed to their full width in reaches long enough to permit proper operation of compaction equipment. Exceptions will be made in certain reaches as required to facilitate direct utilization of random fill material from the required excavations. It will be required that prior to certain flood seasons, all partially completed dike reaches will be completed to their full width, including stone protection.

G. SLOPE PROTECTION

32. General - The riverside slopes of the dikes and the cut slope along the channel improvement on the Naugatuck River will be protected from stream erosion by layers of stone protection on layers of gravel bedding. The landside slope of the dikes will be top soiled and seeded except at the toe where Class IV Stone Protection will be placed to control seepage emerging from the toe drains. Stone protection design and the gradation and layer thickness requirements for Class I, II and III Stone Protection have been presented in approved Design Memorandum No. 3, "Hydraulic Analysis and Riprap Design."

33. Class IV Stone Protection - Class IV stone protection will be furnished by the contractor and will consist of crushed rock fragments graded from 2 to 8 inches in size.

H. PERMANENT CUT SLOPES

34. The only permanent cut slopes on the project will be along the right bank of the Naugatuck River immediately upstream of the Route 34 bridge. Except for a short reach near the bridge, this slope will be excavated to a slope of 1 vertical on 3 horizontal. Near the bridge, the slope will vary from 1 on 3 to 1 on 2. This slope will be provided with stone protection. To assure adequate stability, trash fill materials in the old dump behind this slope will be removed and replaced with compacted earth fill.

I. CONCRETE STRUCTURES - FOUNDATIONS AND SEEPAGE CONTROL

35. Pumping Station

a. Pumping Station Structure - The structure for the pumping station will be built in the vicinity of Station 14+00 on the landside of the Housatonic Dike. Its foundation will be at about Elev. minus 5.0 and will be on moderately compact sandy gravel (GP) and gravelly sand (SP). The estimated foundation loadings for this structure are well within the allowable range for these materials. The foundation drain for the adjacent dike reaches will be continued around the structure. The presently proposed pumping station site is about 425 feet upstream from the site proposed in approved Design Memorandum No. 2 - "General Design." The site was changed when it was found that the foundation at the former site contained layers and lenses of compressible organic soils. It was determined that settlements due to the presence of these soils would probably exceed tolerable limits for the pumping station structure and the pipe lines leading to it as well as for the adjoining conduit and gate structure.

b. Conduit and Gate Structure - The foundation grades for the conduit and gate structure for the pumping station will be at about Elev. minus 5.0. At this depth, foundation soils consist of loose silty medium to fine and coarse to fine sands (SM) in a thin layer overlying loose to moderately compact silty medium to fine and coarse to fine sands (SP and SP-SM) and gravelly sand (SP). The estimated loadings for these structures are within the allowable range for these materials. Above Elev. minus 3.0 in the vicinity of the conduit and gate structure, there are deposits of stratified loose silty fine sand and sandy silt with occasional layers containing organics. The presence of these soils in the foundation of the dike embankment might result in spreading which could open conduit joints and tip the gate structure. To avoid such a possibility, these materials will be removed from the riverside portion of the dike foundation for distance of 50 feet to either side of the conduit. To aid in avoiding tipping of the gate structure, impervious fill material placed within 5 feet of its landside wall will not be compacted.

36. Conduit and Gate Structure for Naugatuck Dike - The conduit and outlet structure for the Naugatuck Dike will be constructed at about Sta. 11+50. The foundation grades will be at about Elev. minus 5.0. The foundation soils are moderately compact sandy silt and silty fine sand (ML and SM classes). Since the area in which the conduit and gate structure are to be built has been used for aggregate stock piles from 30 to 40 feet high, it is estimated that the foundation has, in effect, been preloaded to intensities in excess of the foundation loadings of these structures. No significant settlement or horizontal

displacement therefore is expected. To avoid tipping the gate structure, impervious fill material placed within 5 feet of its landside wall will not be compacted.

37. Railroad Gate No. 1 - Railroad Gate No. 1 will be constructed to the north of the Route 34 overpass on the railroad line to Ansonia. Foundation materials at the gate site include about 13 feet of railroad fill consisting principally of moderately compact gravelly sand and gravelly silty sand (SP and SP-SM) containing over 30 percent gravel sizes. Beneath this fill or between Elev. 0.0 and 5.0, there is a layer of dark brown loose non-plastic silty fine sand (SM) with considerable organic matter and occasional brick fragments. Samples from this layer appeared to be compressible. Below Elev. 0.0 there is a 5-foot layer of loose micaceous sand (SP) overlying about 7 feet of compact sandy gravel (GP). At present, it is planned to place the gate foundation below the possibly compressible layer. The estimated foundation loadings are within the allowable range for the soils below this layer and no significant settlement is anticipated. A landside drainage zone will be provided to control seepage through the foundation of the structure. Consideration is being given to an alternate gate structure design with a foundation grade above the possibly compressible foundation layer. In this design, the gate structure would be dimensioned so as to reduce total bearing pressures and to distribute these pressures as evenly over the base as possible. This alternate design will be adopted only if it is determined that the anticipated differential settlements would be structurally tolerable.

38. Railroad Gate No. 2

a. General - Railroad Gate No. 2, located to the west of Conn. Route 8 and north of the sewage treatment plant, will consist of two gate structures and a connecting T-wall. The northerly gate structure - Gate 2N - will be built across an industrial spur track. The southerly gate structure - Gate 2S - will be built across two tracks, the wye track connecting the Ansonia and Maybrook lines and the track for the Maybrook line.

b. Gate 2N - Foundation materials at the site for Gate 2N include about 10 feet of fill consisting of loose gravelly silty sands (SM and SP-SM) with minor cinders and asphalt fragments. This fill is underlain by a somewhat compressible zone of about 7 feet of loose to moderately compact sandy organic silt (OL) and silty fine sand (SM) with organics. This zone overlies about 3 feet of moderately compact silty medium to fine sand (SM) which in turn overlies about 13 feet of moderately compact sandy gravel (GW) with boulders. The base for Gate 2N will be at Elev. minus 1.0 in moderately compact granular soil. The estimated loadings for the structure are well within the allowable range for such foundation materials and no significant settlements are anticipated. A landside drainage zone will be provided to control seepage through the foundation of the structure.

c. Gate 2S - Foundation materials at the site for Gate 2S include from 10 to 18 feet of fill consisting of essentially granular materials. The fill materials beneath the wye track are moderately compact while those beneath the track of the Maybrook line are loose and contain the remnants of a timber trestle including piling. A

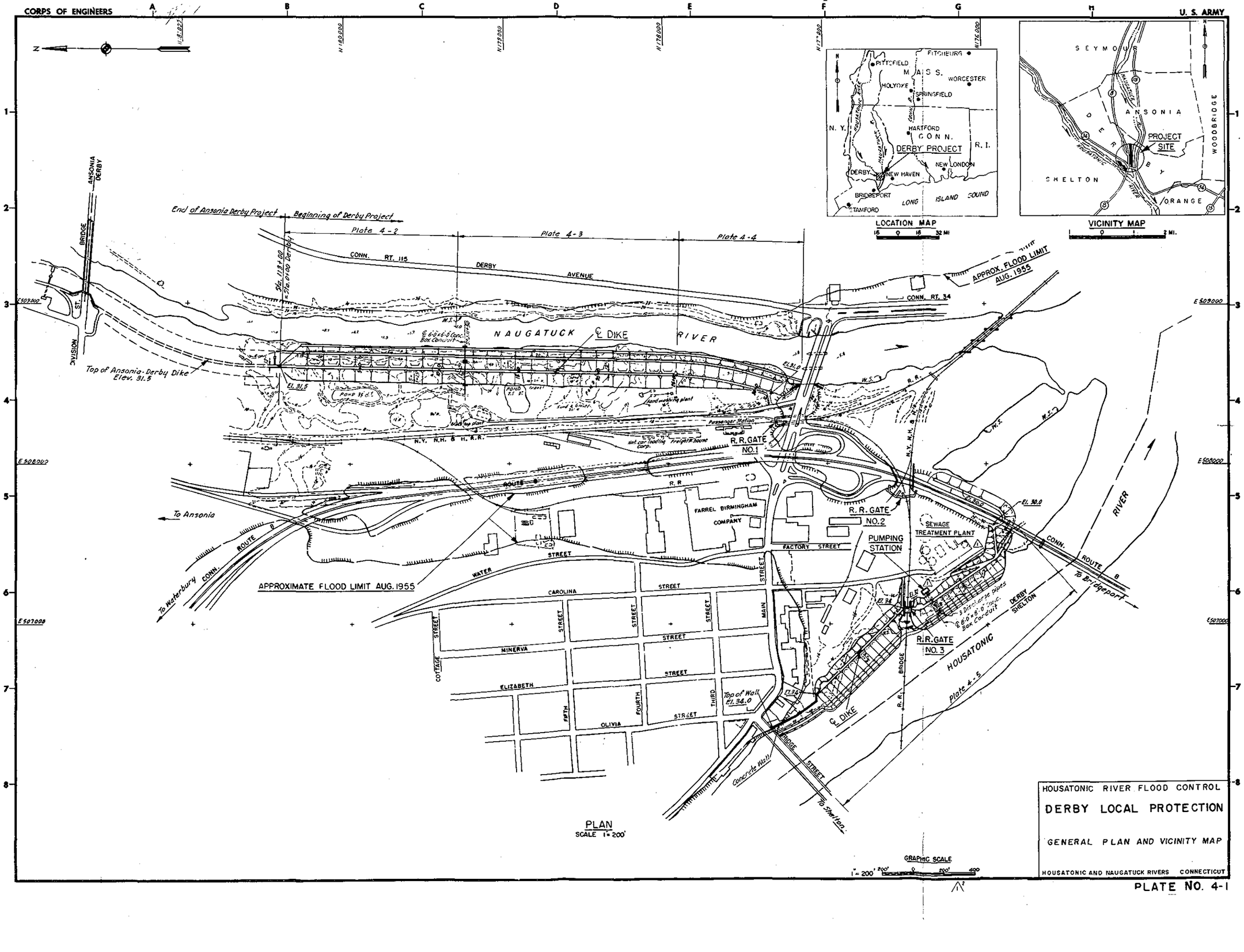
3 to 5 foot zone of somewhat compressible moderately compact sandy silt (ML) and silty medium to fine sand (SM) with some sandy organic silt (OL) underlies the fill. Moderately compact gravelly silty sand (SP-SM), sand (SP) and sandy gravel (GP) underlie this zone. The base for Gate 2S will be at Elev. 0.0 in these moderately compact granular soils. The estimated loadings for the structure are well within the allowable range for these materials and no significant settlement is anticipated. A landside drainage zone will be provided to control foundation seepage. All existing timber piles encountered during construction will be cut off at least one foot below the base slab.

d. T-Wall - The T-wall will connect Gate 2N and 2S. Foundation conditions at the ends of the wall are as described for the corresponding gate. Between the gates, however, foundation materials include a fill of loose cinders and ashes extending from the ground surface to about El. 5.0. This fill overlies up to about 11 feet of loose to moderately compact sandy silt (ML) and silty fine sand (SM) with pieces of rotted wood and occasional decayed vegetation. These somewhat compressible materials are underlain by moderately compact sandy gravel (GP). Alternate foundation designs for the T-wall are being studied. All include the removal of the cinders and ashes and establishing the base of the wall at Elev. 8.0 on compacted gravel fill. Whether or not the somewhat compressible materials under the cinders and ashes will be removed will depend upon the amount of differential settlement that can be tolerated structurally. Consideration is also being given to the use of a pile foundation for the wall.

39. Railroad Gate No. 3 - Railroad Gate No. 3 will be constructed across the Maybrook line on the Housatonic Dike alignment. The track at this location is on an embankment rising from 10 to 12 feet above the adjacent ground surface. The embankment fill consists of moderately compact silty sandy gravel (GP-GM) and silty medium to fine sand (SM) and includes remnants of an old timber trestle. There is an old refuse dump along the north side of the embankment and it appears that the north portion of the railroad embankment was built on the dump. The base for this gate will be at Elevation minus 2.0, well below the bottom of the trash fill materials in the dump. Foundation materials at this level will consist of moderately compact gravelly silty sand (SP-SM and SW-SM). The estimated loadings for the structure are well within the allowable range for such soils and no significant settlements are anticipated. All existing timber piles encountered during construction will be cut off at least one foot below the base slab. A landside drainage zone will be provided to control foundation seepage.

CORPS OF ENGINEERS

U. S. ARMY



HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

GENERAL PLAN AND VICINITY MAP

HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-1

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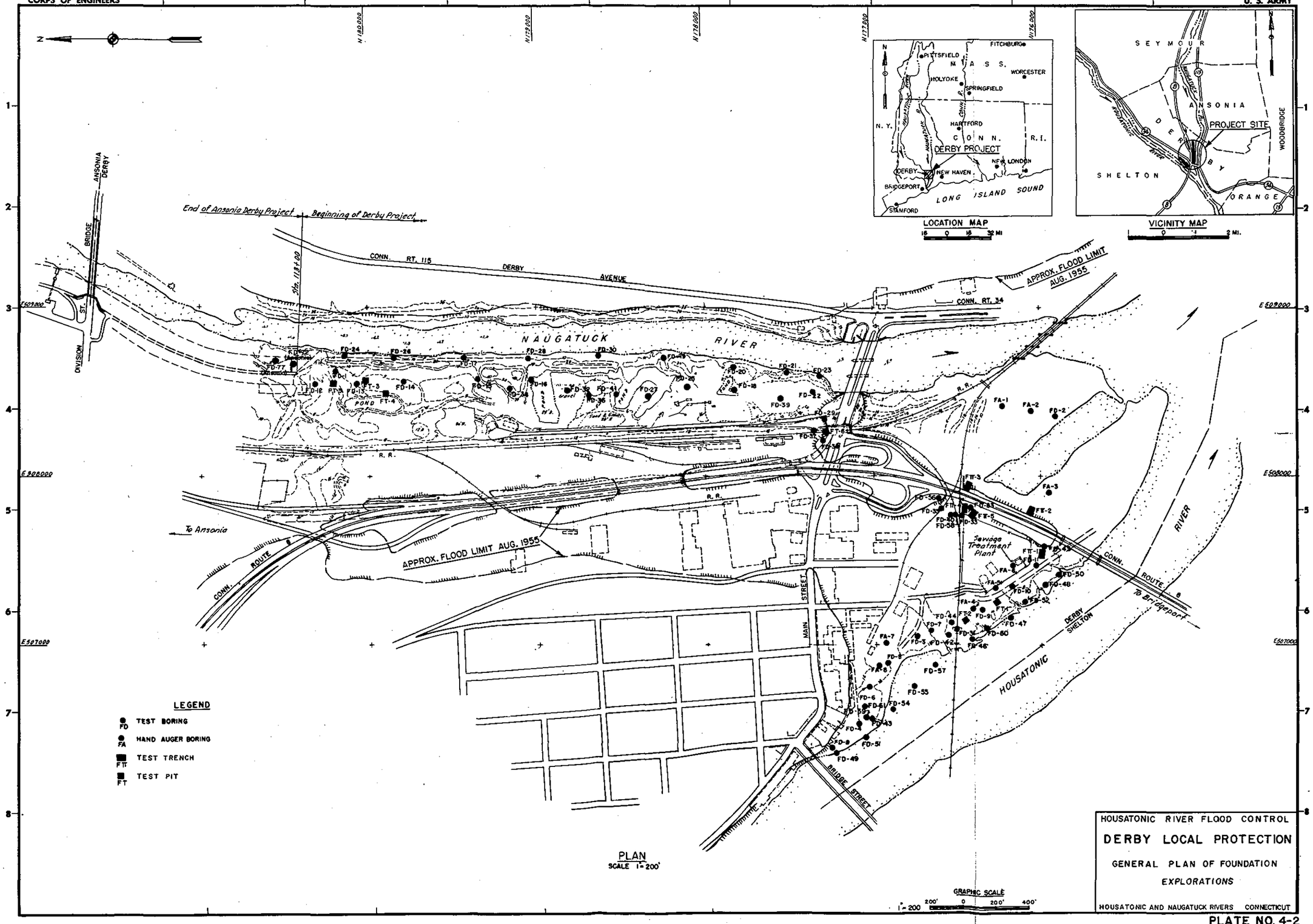

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

GENERAL PLAN OF FOUNDATION EXPLORATIONS

HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-2

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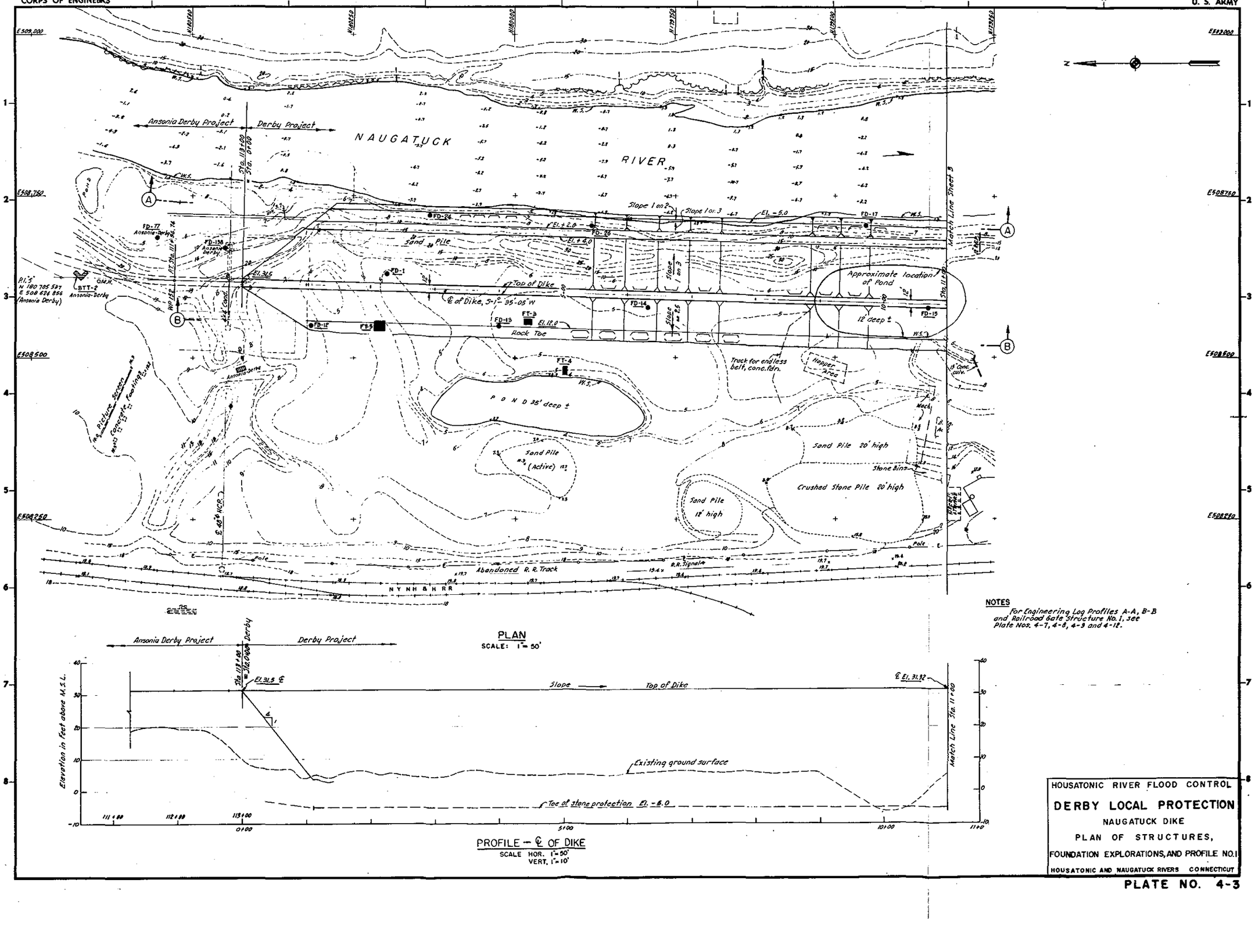

NOTES

For Engineering Log Profiles A-A, B-B and Railroad Gate Structure No. 1, see Plate Nos. 4-7, 4-8, 4-9 and 4-12.

PLAN

SCALE: 1" = 50'

PROFILE — ℄ OF DIKE

SCALE HOR. 1"=50'
VERT. 1"=10'

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

NAUGATUCK DIKE

PLAN OF STRUCTURES, FOUNDATION EXPLORATIONS, AND PROFILE NO.1

HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-3

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NAUGATUCK RIVER

Notch Line Sheet 4

Notch Line Sheet 8

Approx. location of pond

Access Bridge

Sluice Gate Structure

Flap Valve

6'-0" x 6'-0" Concrete Box Conduit

Stacked Gravel

Slope 1 on 2

Slope 1 on 3

Slope 1 on 2.5

Excavate to El. 0.0

Control line

Top of Dike

℄ of Dike

Sand Pile 10' h.

Gravel Pile 10' to 20' high

Toe of Pile

Rock Toe

POND

2.5' deep

Washed Gravel Pile (Active)

Water Pump 4" C.I.P.

Sand washing Plant

Conveyor belts

Steel bins

Shed

Loading bin

Trans.

Rock & Dirt

Sand Pile 15' high

Steel girders and conveyor belts

Top of Gravel Pile 10' high

Sand and Gravel Pile 20' high

Transformer

Concast Black Top plant

Building (Conc. Block)

Black Top area

Black Top roadway

Black Top (poor condition)

Abandoned R.R. Track

N.Y. N.H. & H. R.R.

Garage & Office building (conc. block)

Hand operated crane

National Car Loading Corp.

Platform Ramp

Freight Ware house

Pole

E 509000

E 508750

E 508500

E 508250

N 128500

N 128750

N 129000

N 129250

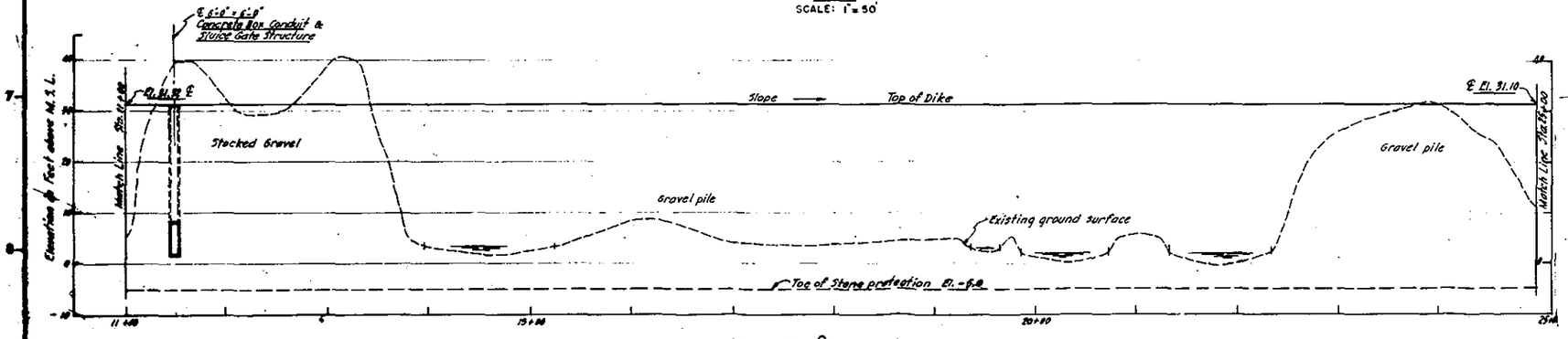
N 129500

N 129750

N 130000

PLAN

SCALE: 1" = 50'



PROFILE — ℄ OF DIKE

SCALE HOR. 1" = 50'
VERT. 1" = 10'

NOTES

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

NAUGATUCK DIKE

PLAN OF STRUCTURES, FOUNDATION EXPLORATIONS, AND PROFILE NO. 2

HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-4

CORPS OF ENGINEERS

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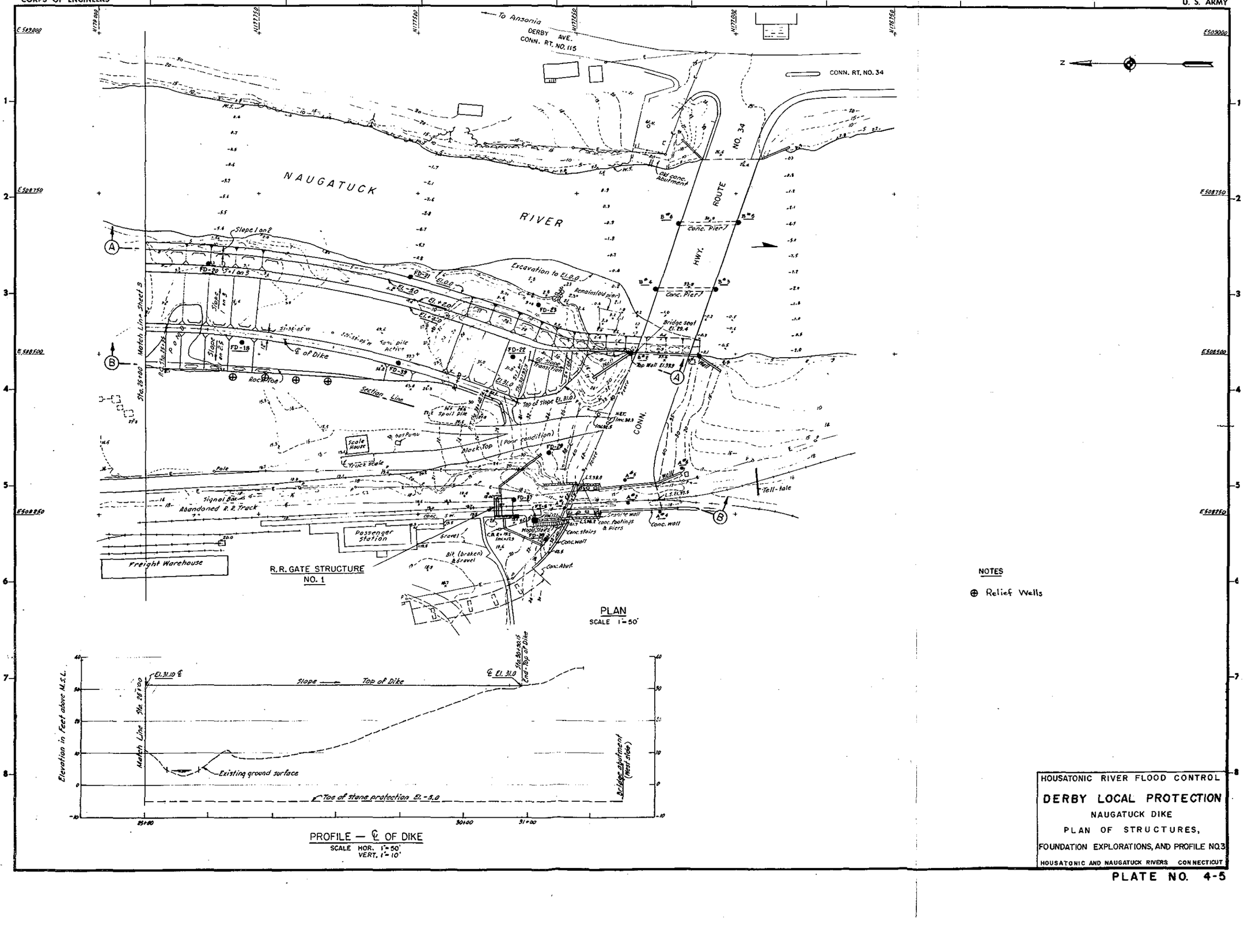


NOTES

⊕ Relief Wells

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

NAUGATUCK DIKE

PLAN OF STRUCTURES, FOUNDATION EXPLORATIONS, AND PROFILE NO.3

HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-5

CORPS OF ENGINEERS

U. S. ARMY

PLAN
SCALE 1"=50'

PROFILE — ℄ OF DIKE
SCALE HOR. 1"=50'
VERT. 1"=10'

NOTES

For Engineering Log Profiles C-C, D-D, and Railroad Gate Structure No. 2, see Plate No. 4-10, 4-11 and 4-12.

⊕ Relief Wells

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

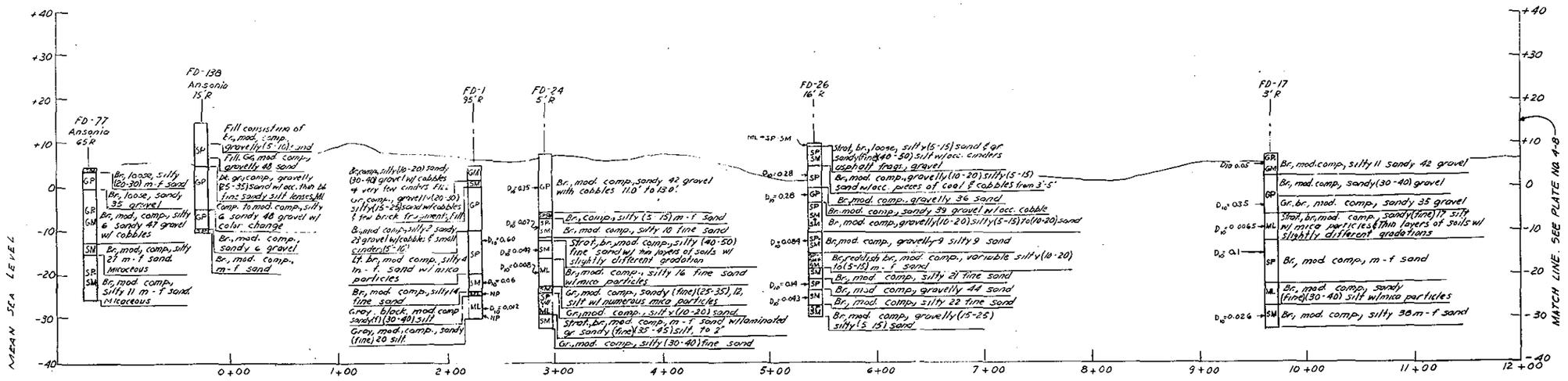
HOUSATONIC DIKE

PLAN OF STRUCTURES, FOUNDATION EXPLORATIONS, AND PROFILE NO.4

HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

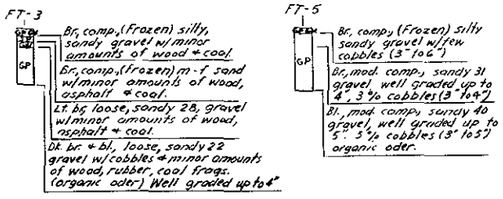
PLATE NO. 4-9

CORPS OF ENGINEERS — U. S. ARMY



ENGINEERING LOG PROFILE A-A, 120 FEET RIVERSIDE FROM DIKE ℄

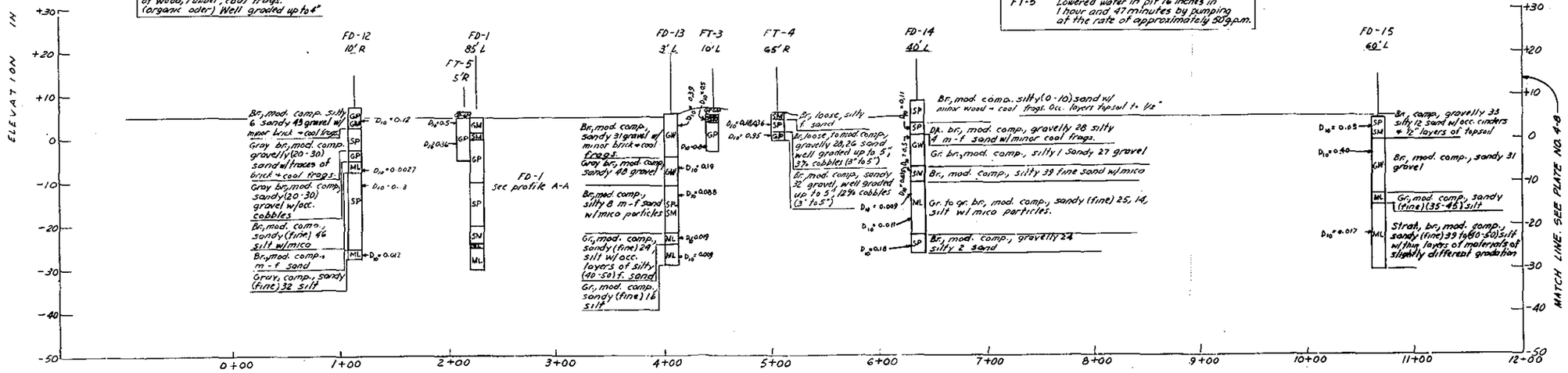
(LOOKING TOWARD RIVER - PROJECTED DIKE ℄ STATIONING)



PUMPING TESTS

FT-3 Lowered water in pit 18 inches in 48 minutes by pumping at the rate of approximately 50 g.p.m.

FT-5 Lowered water in pit 16 inches in 1 hour and 47 minutes by pumping at the rate of approximately 50 g.p.m.



ENGINEERING LOG PROFILE B-B, 60 FEET LANDSIDE FROM DIKE ℄

(LOOKING TOWARD RIVER - PROJECTED DIKE ℄ STATIONING)

LEGEND FOR ENGINEERING LOG PROFILES

Strat.	Stratified	LL	Atterberg liquid limit
org.	organic	NP	non plastic
lt.	light	Wn	Natural water content of sample except for certain soils containing gravel for which Wn represents the water content of that part of the sample from which portions of the coarse gravel sizes have been removed.
dk.	dark		
gr.	gray		
br.	brown		
bl.	black		
mod.	moderately		
v.	very	Wa	Natural water content determined for that portion of the soil passing the No.4 U.S. standard sieve.
comp.	compact		
w/	with		
occ.	occasional	26	A single numeral following a soil component in the description of a soil represents the percentage, by weight, of that component in the soil as determined by a mechanical analysis.
f.	fine		
m.	medium		
c	coarse		
m-f	medium to fine		
D10	Effective grain size in millimeters.		

(25-35) A range of numbers in parentheses following a soil component in the description of a soil represents the estimated limits between which lies the percentage, by weight, of that component in the soil as determined by visual inspection.

SM Soil Symbol, Unified Soil Classification System

Cobble or boulder (Core-drilled)

Cobble or boulders, continuous or nested (Core drilled and/or blasted or chopped)

NOTE: For location of explorations, see Plate No. 4-3.

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

NAUGATUCK DIKE

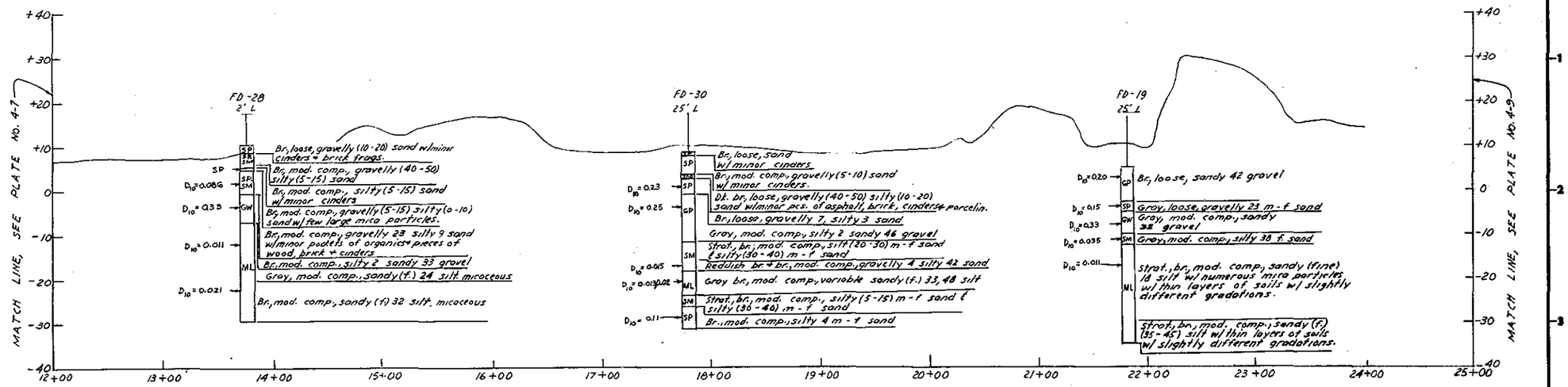
ENGINEERING LOG PROFILES

A-A AND B-B

HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

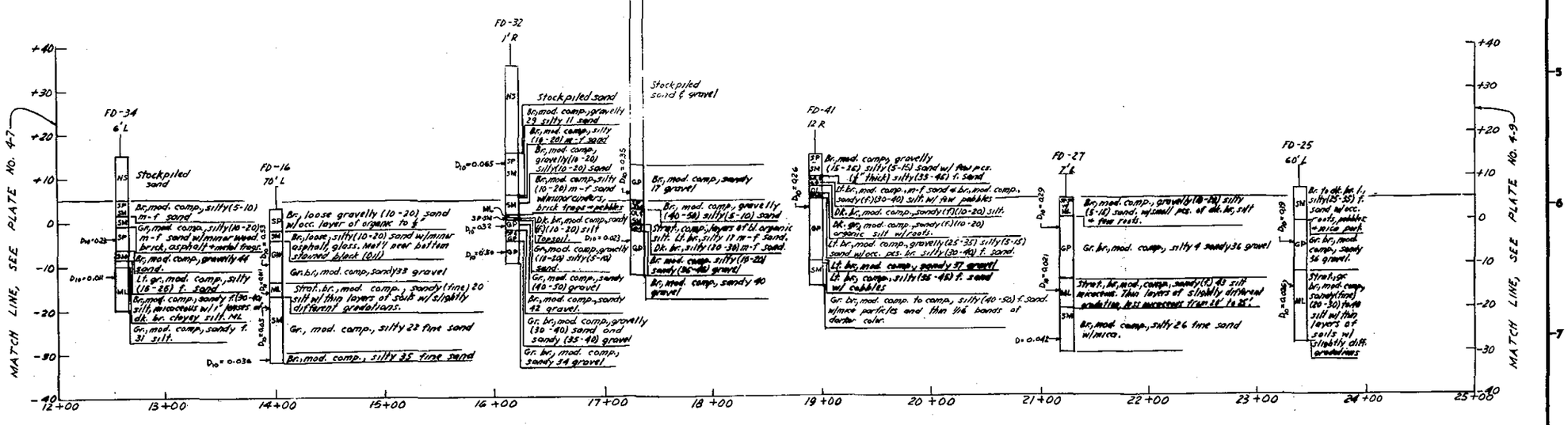
PLATE NO. 4-7

CORPS OF ENGINEERS — U. S. ARMY



ENGINEERING LOG PROFILE A-A, 120 FEET RIVERSIDE FROM DIKE ℄

(LOOKING TOWARD RIVER - PROJECTED DIKE ℄ STATIONING)



ENGINEERING LOG PROFILE B-B, 60 FEET LANDSIDE FROM DIKE ℄

(LOOKING TOWARD RIVER - PROJECTED DIKE ℄ STATIONING)

NOTE
For location of explorations, see Plate No. 4-4
For Legend of Engineering Logs, see Plate No. 4-7

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

NAUGATUCK DIKE

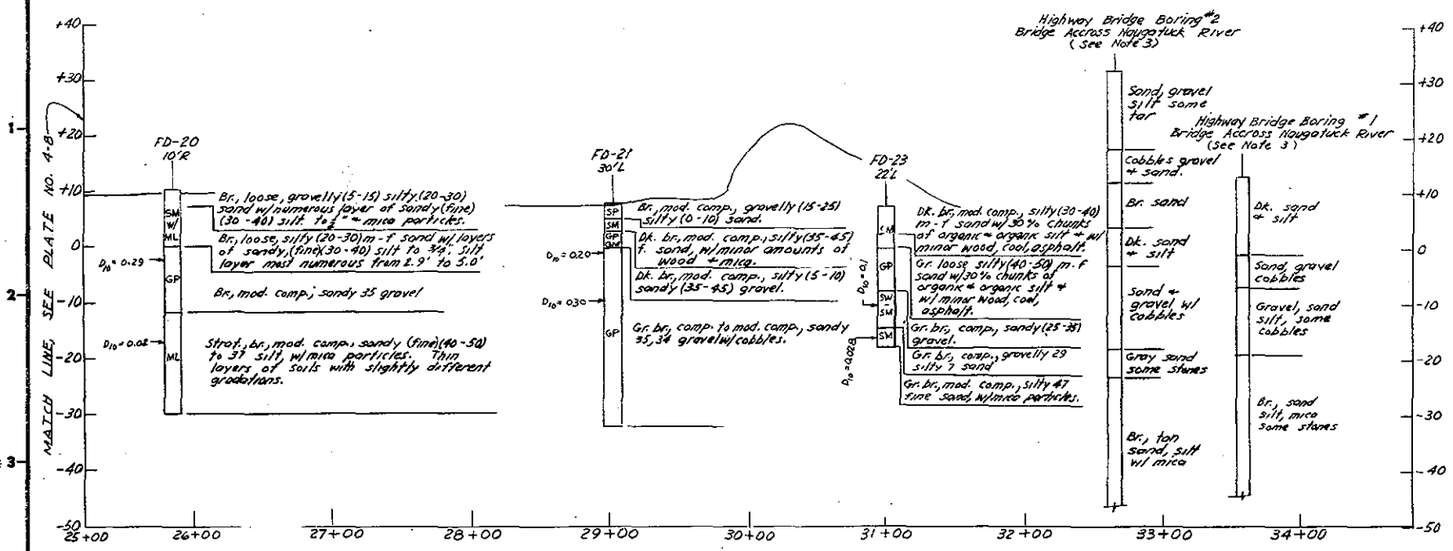
ENGINEERING LOG PROFILES

A-A AND B-B (CONT.)

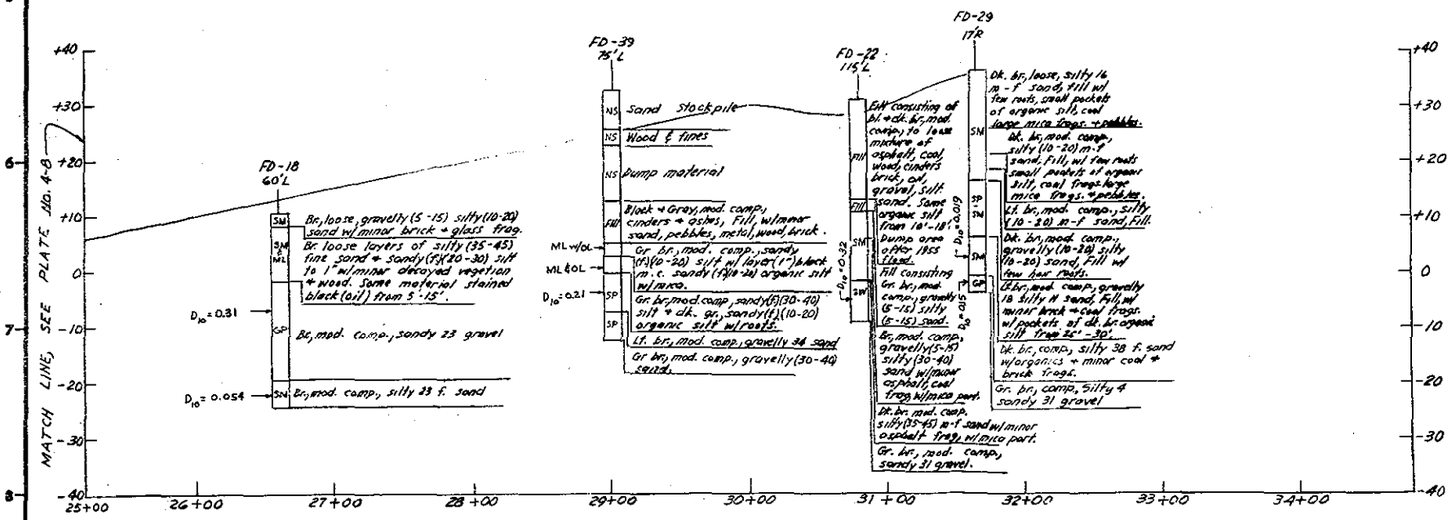
HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-8

CORPS OF ENGINEERS — U. S. ARMY



ENGINEERING LOG PROFILE A-A, 120 FEET RIVERSIDE FROM DIKE ℄
(LOOKING TOWARD RIVER - PROJECTED DIKE ℄ STATIONING)



ENGINEERING LOG PROFILE B-B, 60 FEET LANDSIDE FROM DIKE ℄
(LOOKING TOWARD RIVER - PROJECTED DIKE ℄ (STATIONING)

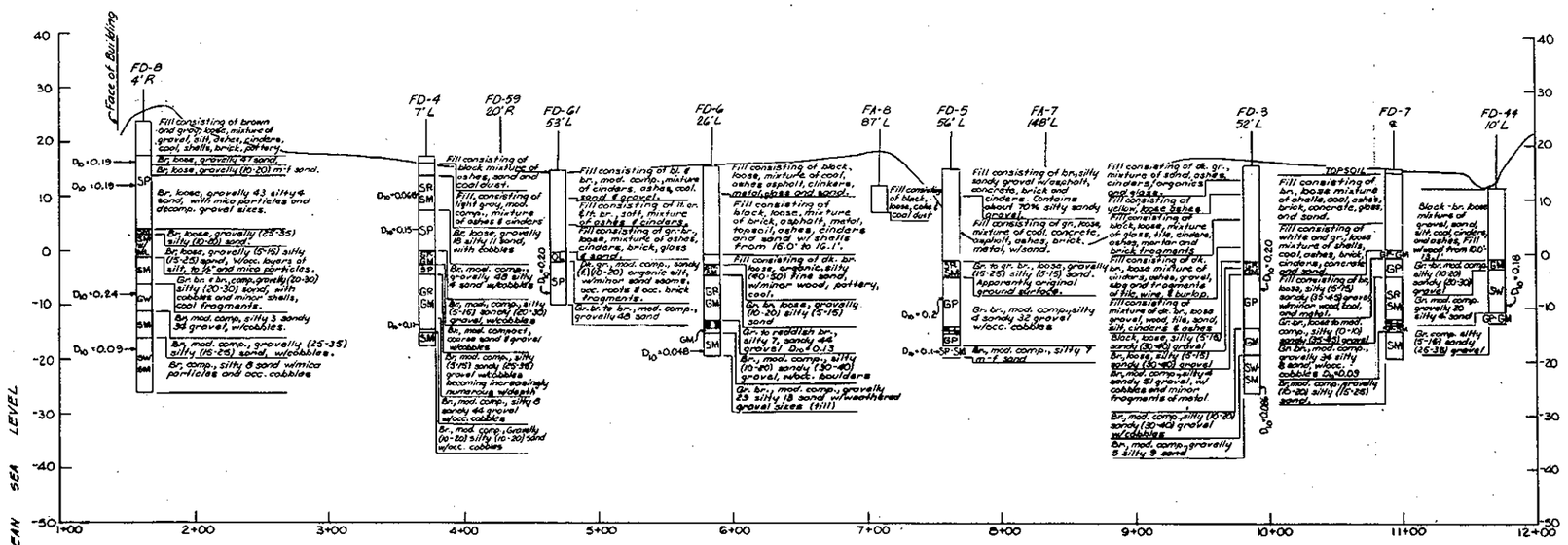
NOTES
1. For location of explorations, see Plate No. 4-5
2. For legend of engineering logs, see Plate No. 4-7
3. Description taken from State Highway Boring Logs.

HOUSATONIC RIVER FLOOD CONTROL
DERBY LOCAL PROTECTION
NAUGATUCK DIKE
ENGINEERING LOG PROFILES
A-A AND B-B (CONT.)
HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

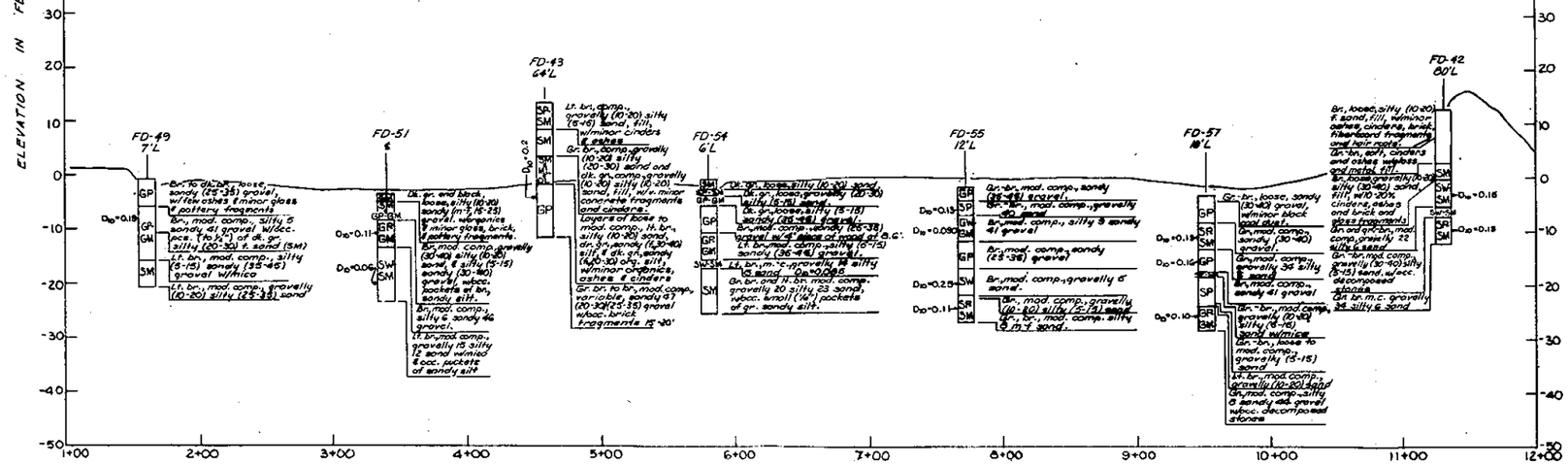
PLATE NO. 4-9

CORPS OF ENGINEERS

U. S. ARMY



ENGINEERING LOG PROFILE C-C
(LOOKING TOWARD LANDSIDE, PROJECTED ℄ STATIONING)



ENGINEERING LOG PROFILE D-D, RIVERSIDE FROM DIKE AND FLOODWALL ℄
(LOOKING TOWARD LANDSIDE, PROJECTED ℄ STATIONING)

NOTES:

For location of explorations, see Plate No. 4-6.

For Legend of Engineering Logs, see Plate No. 4-7.

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

HOUSATONIC DIKE

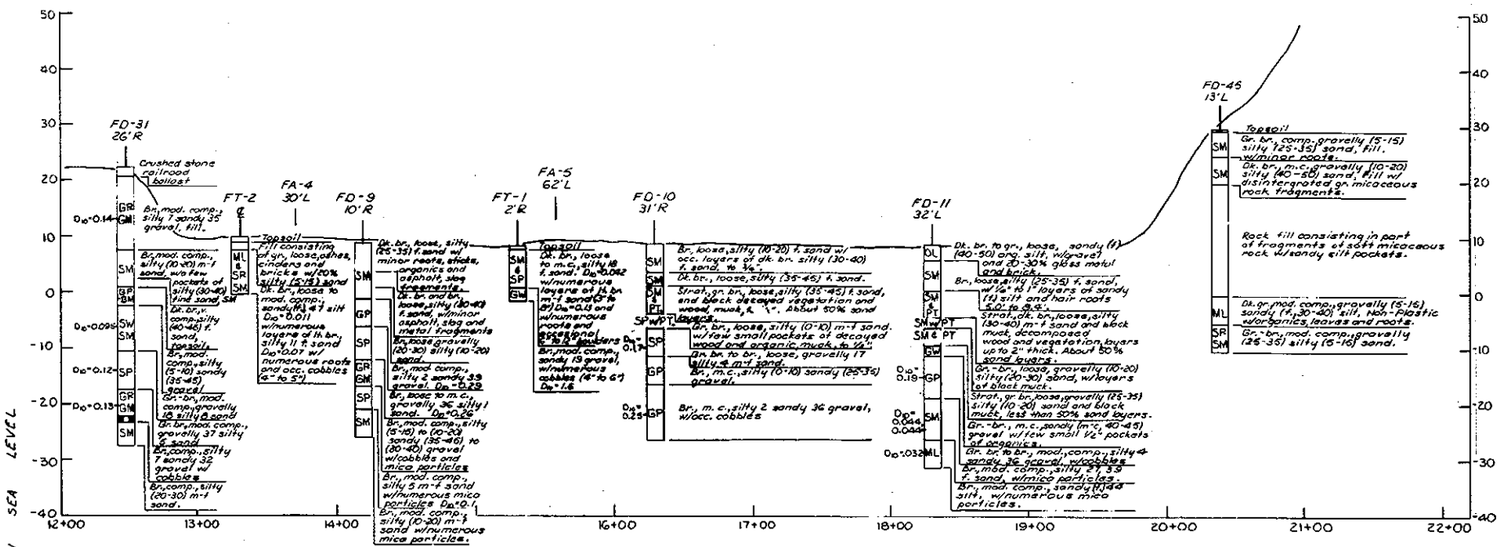
ENGINEERING LOG PROFILES

C-C AND D-D

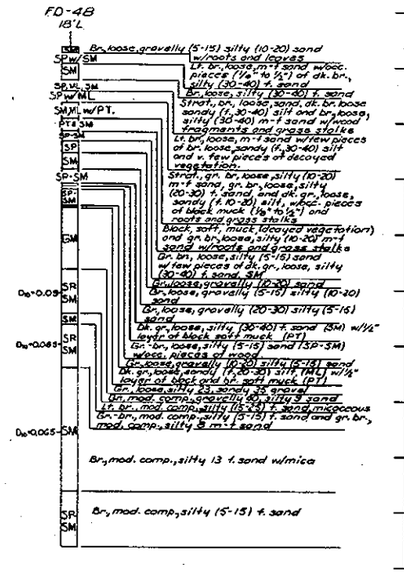
HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

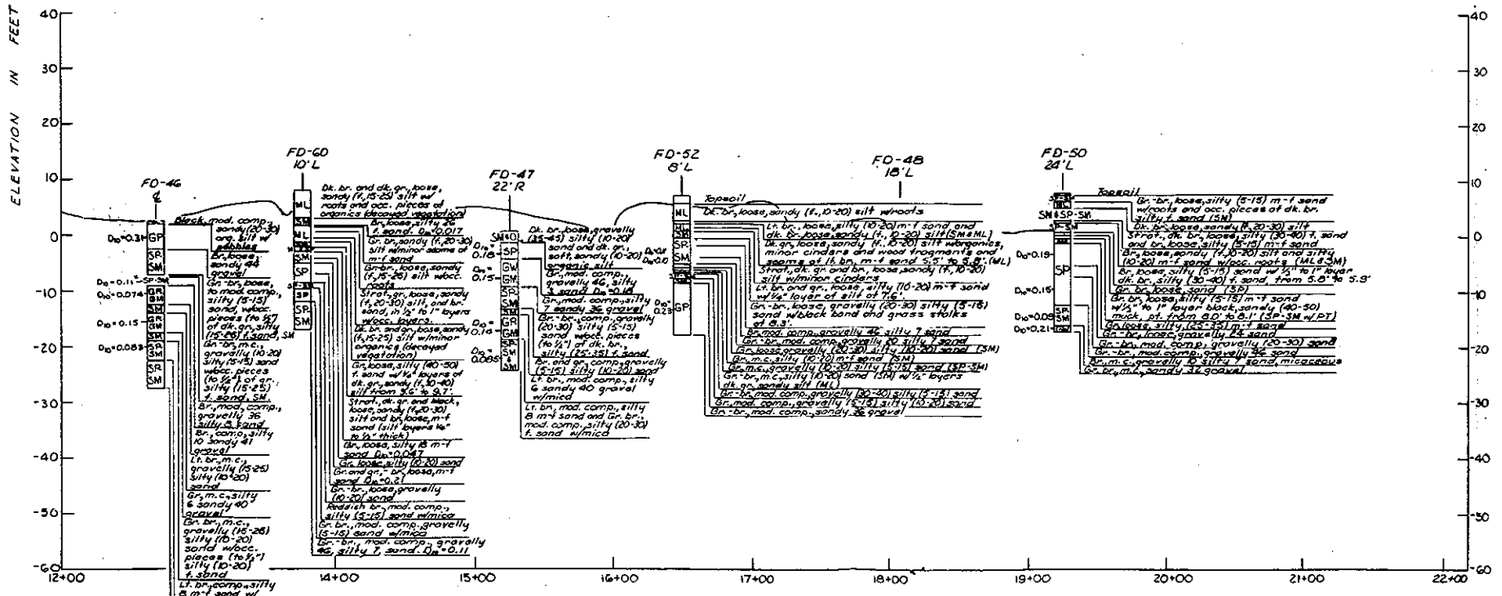
PLATE NO. 4-10

CORPS OF ENGINEERS — U. S. ARMY

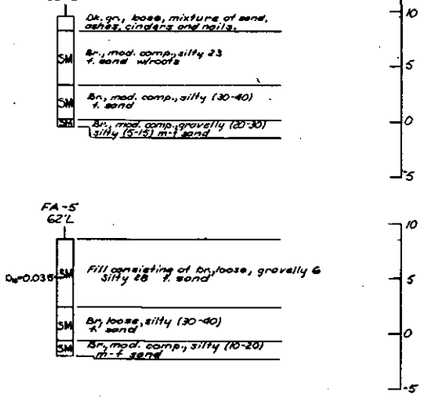


ENGINEERING LOG PROFILE C-C
(LOOKING TOWARD LANDSIDE, PROJECTED ℄ STATIONING)





ENGINEERING LOG PROFILE D-D, RIVERSIDE FROM DIKE AND FLOODWALL ℄
(LOOKING TOWARD LANDSIDE, PROJECTED ℄ STATIONING)



NOTES

For location of explorations, see Plate No. 4-6.

For Legend of Engineering Logs, see Plate No. 4-7.

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

HOUSATONIC DIKE

ENGINEERING LOG PROFILES

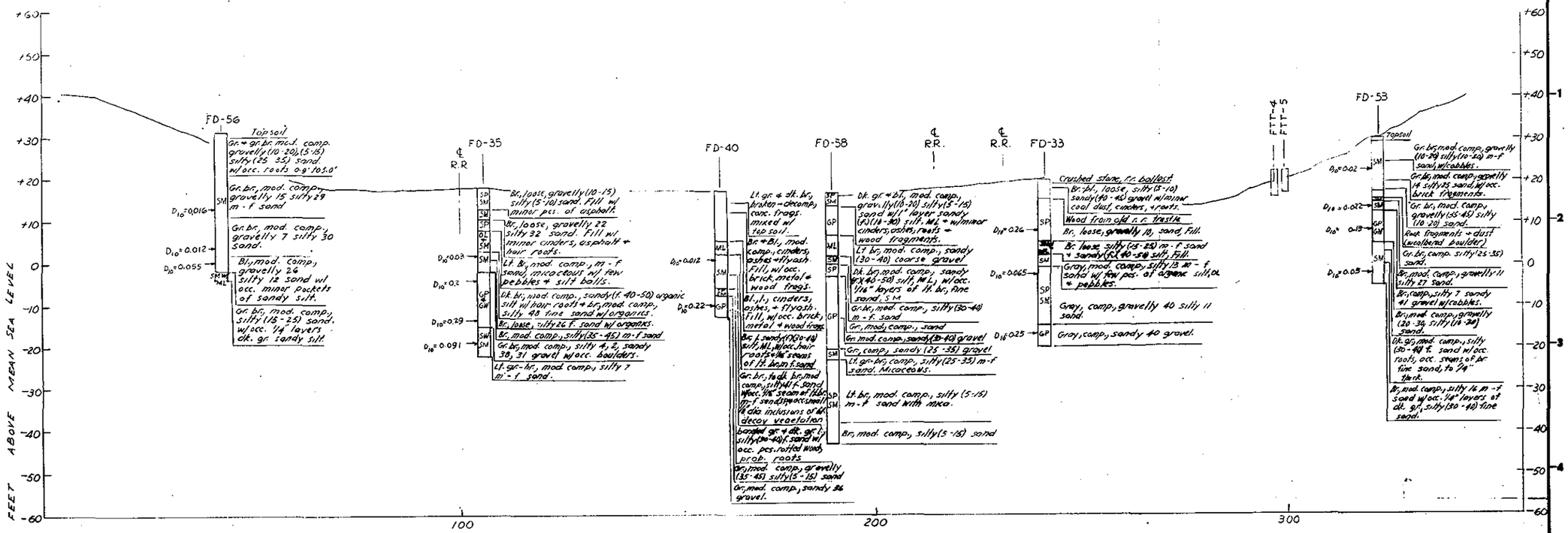
C-C AND D-D (CONT.)

HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

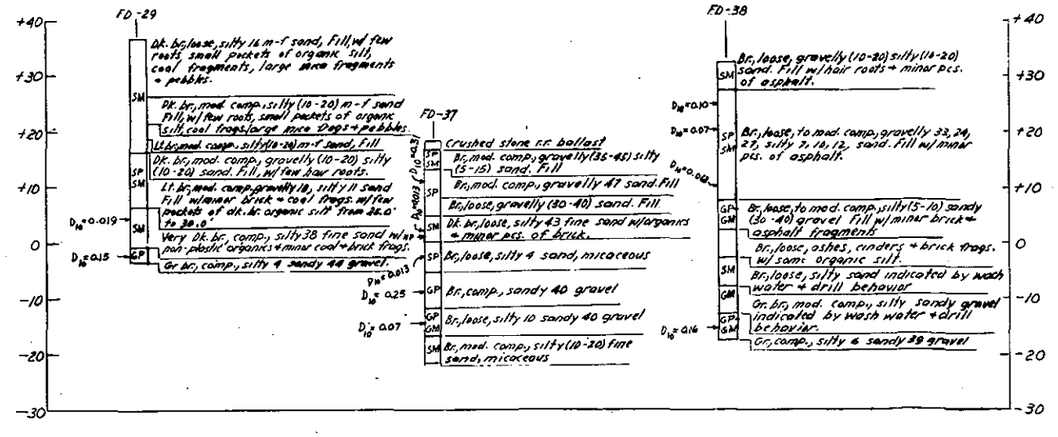
PLATE NO. 4-11

CORPS OF ENGINEERS

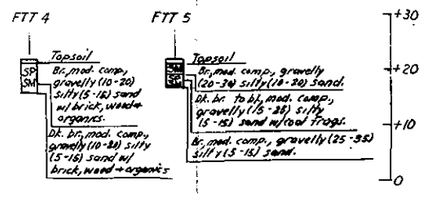
U. S. ARMY



ENGINEERING LOG PROFILE - GATE #2
(LOOKING TOWARD RIVER)



ENGINEERING LOGS - GATE #1
(LOOKING TOWARD RIVER)



NOTES

For location of explorations, see Plate Nos. 4-5 and 4-6.
For legend of Engineering Logs see Plate No. 4-7.

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

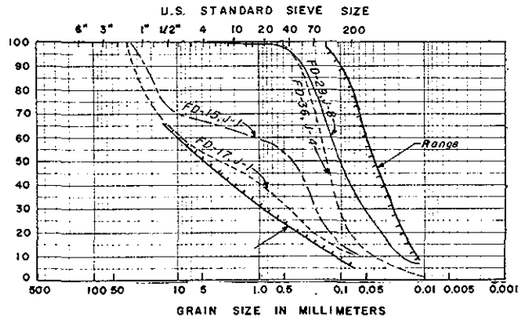
ENGINEERING LOGS - R. R. GATE NO. 1

ENGINEERING LOG PROFILE - R.R. GATE NO. 2

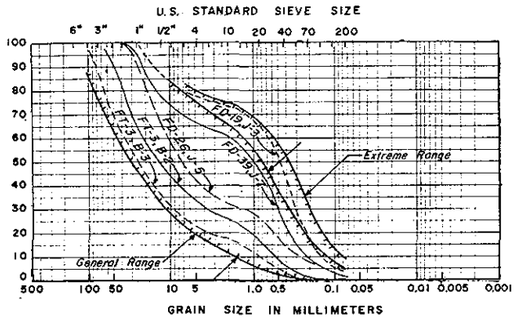
HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-12

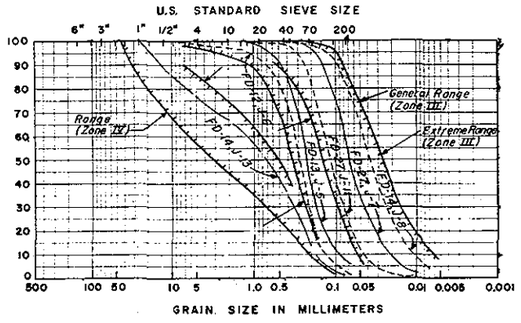
CORPS OF ENGINEERS U. S. ARMY



ZONE I

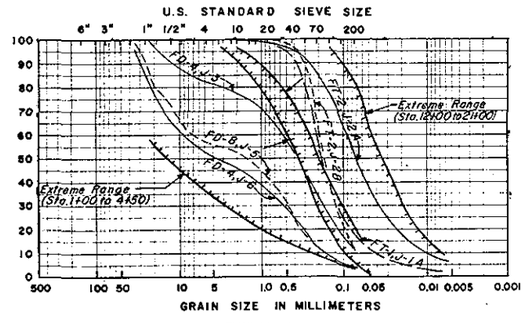


ZONE II

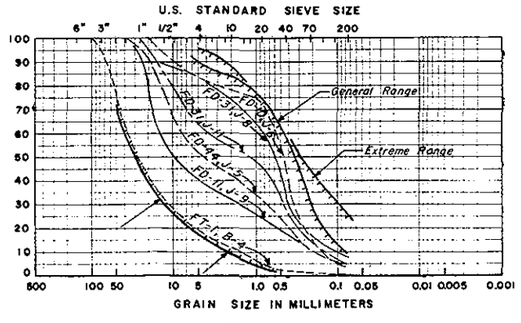


ZONE III AND IV

NAUGATUCK DIKE

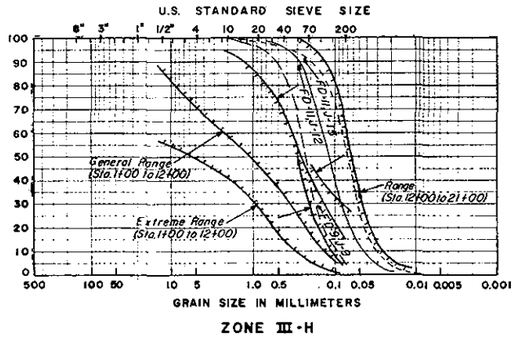


ZONE I-H



ZONE II-H

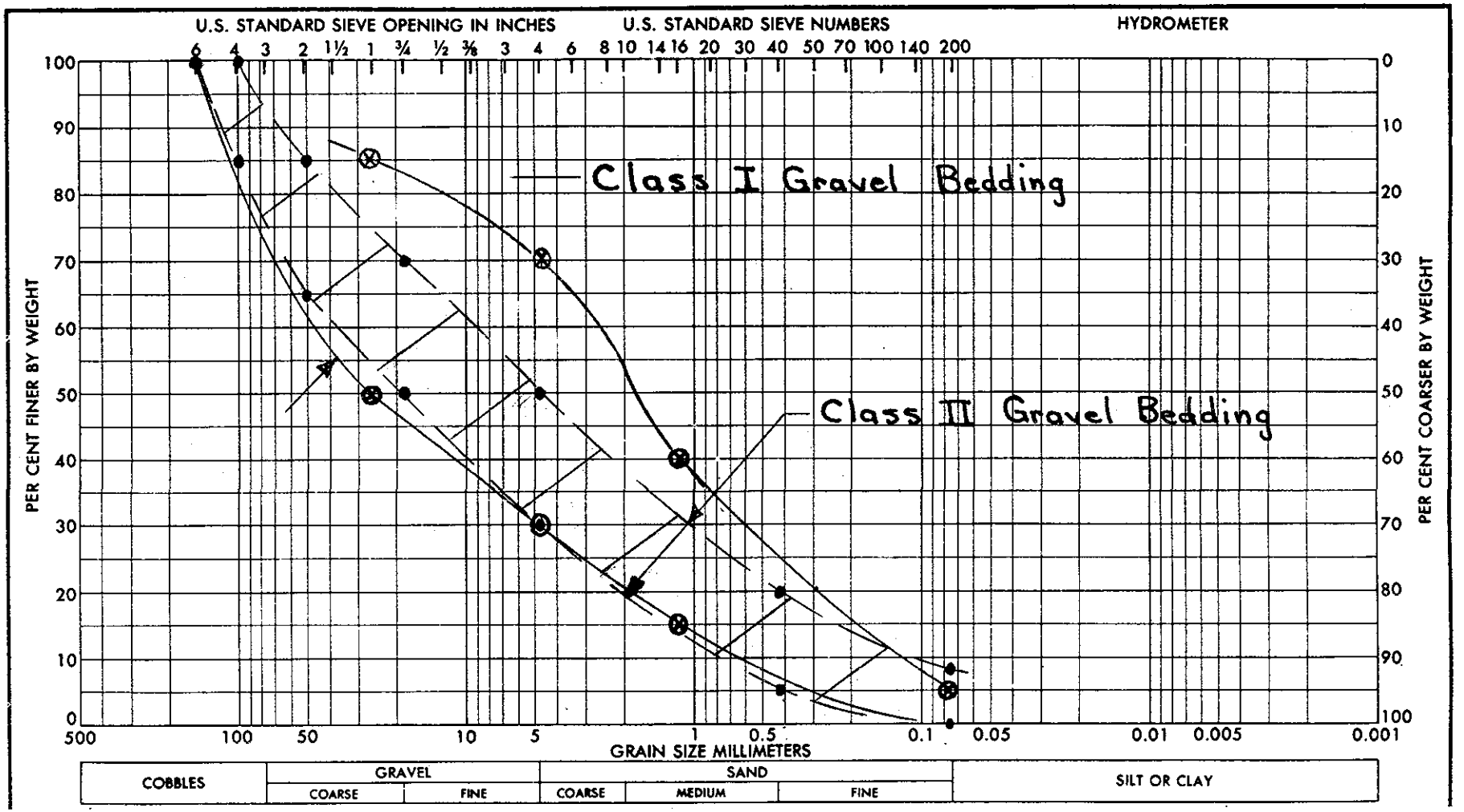
HOUSATONIC FLOODWALL AND DIKE



ZONE III-H

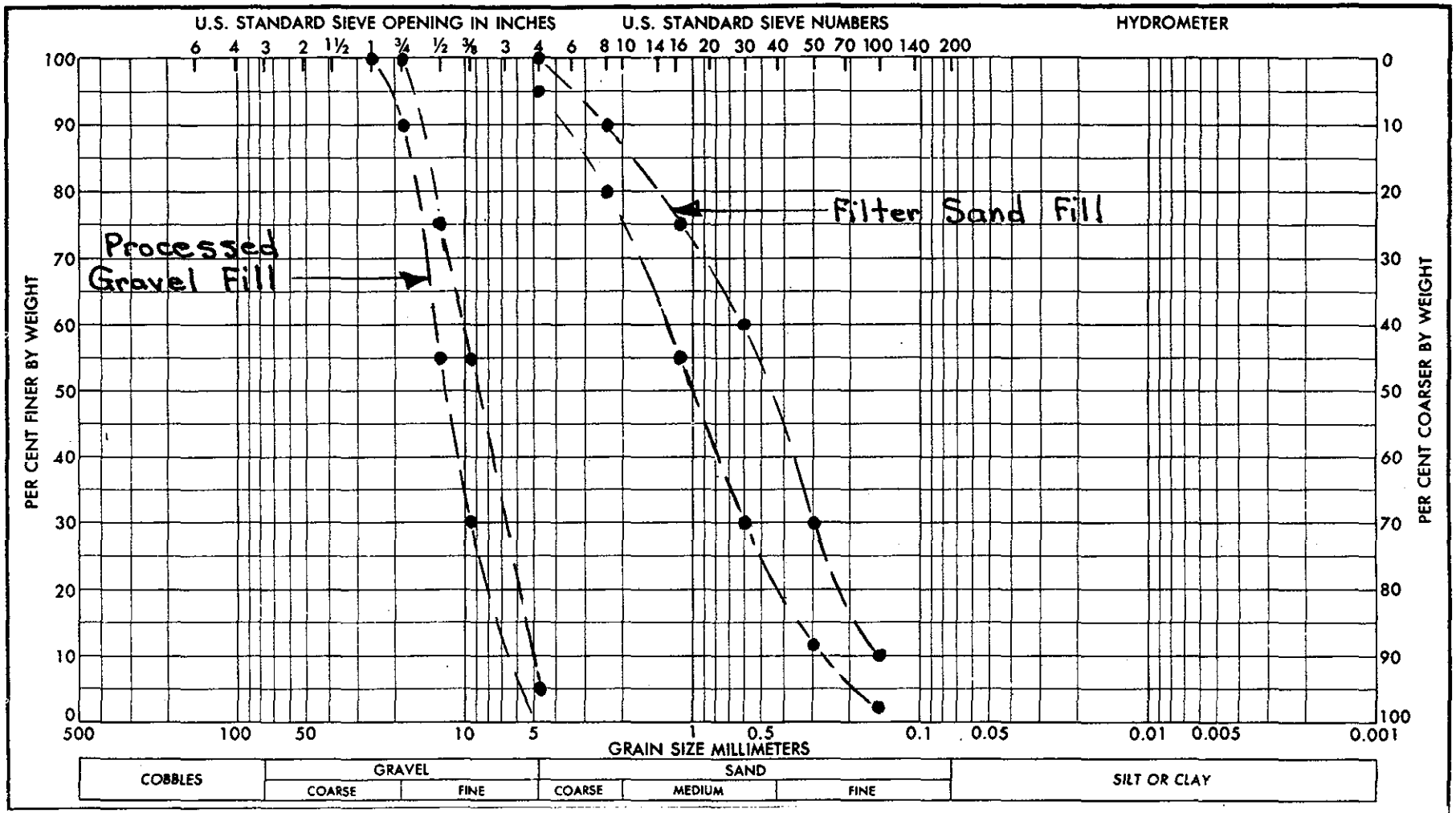
HOUSATONIC RIVER FLOOD CONTROL
DERBY LOCAL PROTECTION
SELECTED TEST DATA
FOUNDATION MATERIALS
HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-13



DERBY LOCAL PROTECTION
GRADATION SPECIFICATIONS
CLASS I AND II GRAVEL BEDDING

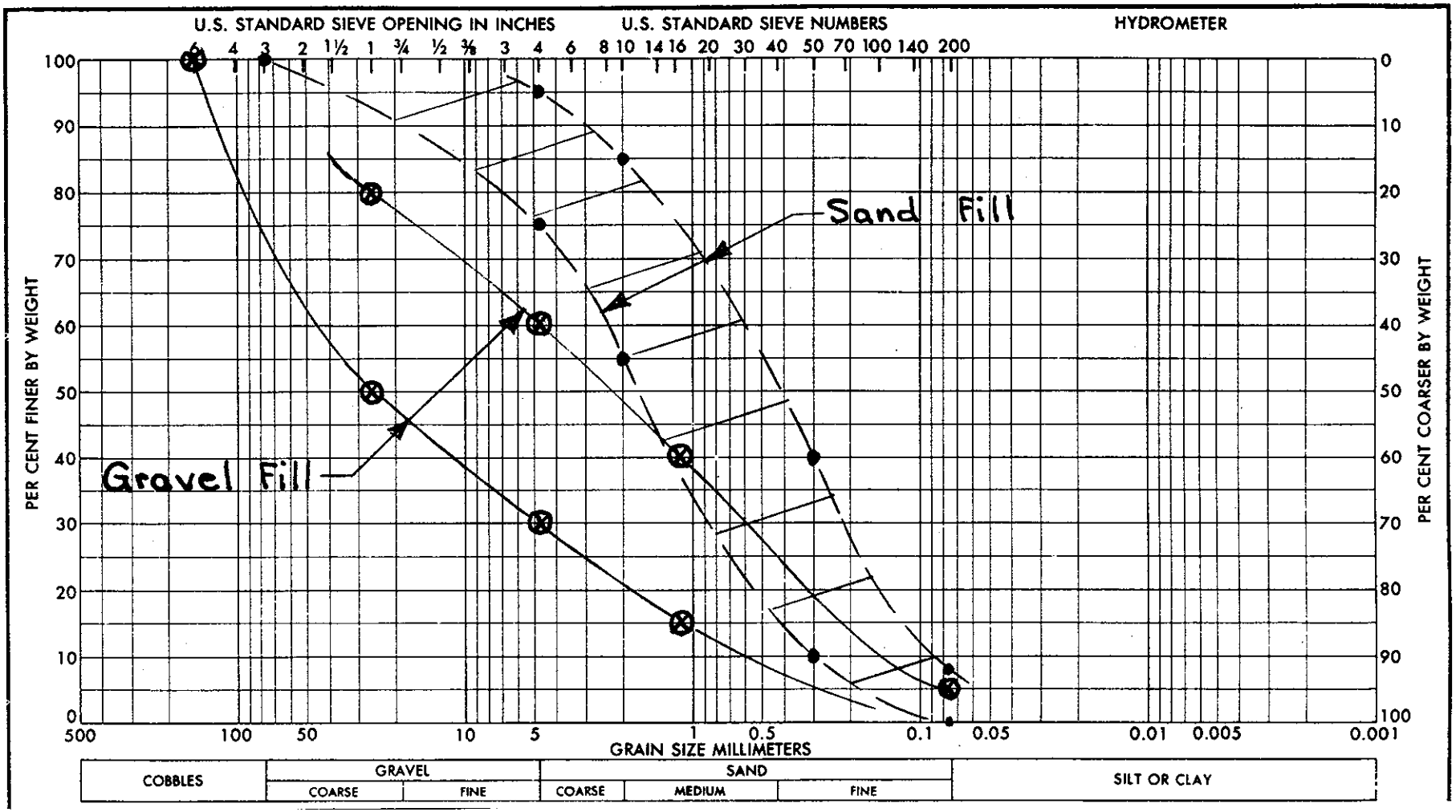
PLATE NO. 4-14



DERBY LOCAL PROTECTION
GRADATION SPECIFICATIONS
PROCESSED GRAVEL FILL AND FILTER SAND FILL

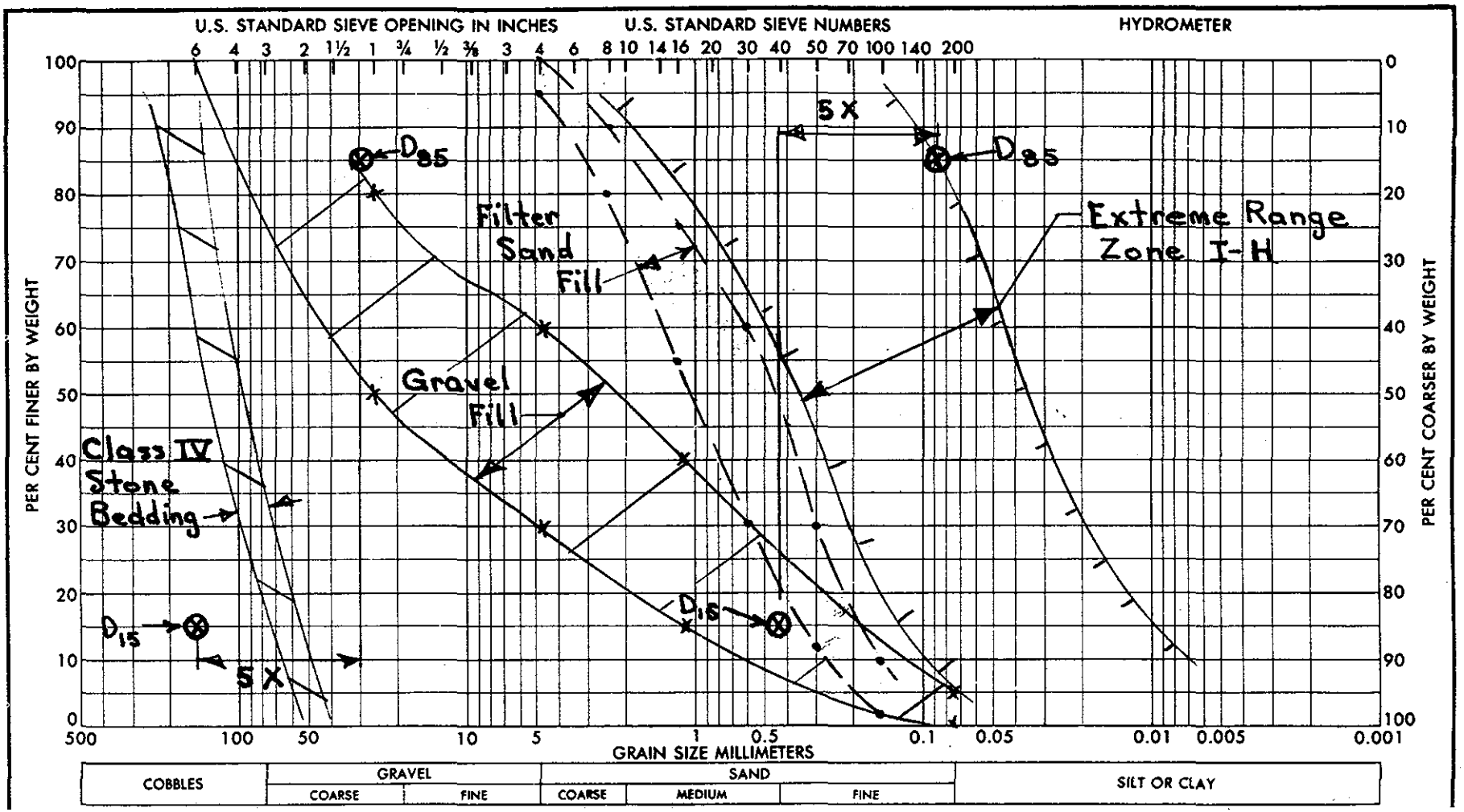
PLATE NO. 4-15

ENG FORM 2087
1 MAY 63
REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.
U.S. GOVERNMENT PRINTING OFFICE : 1963 OF—709-126



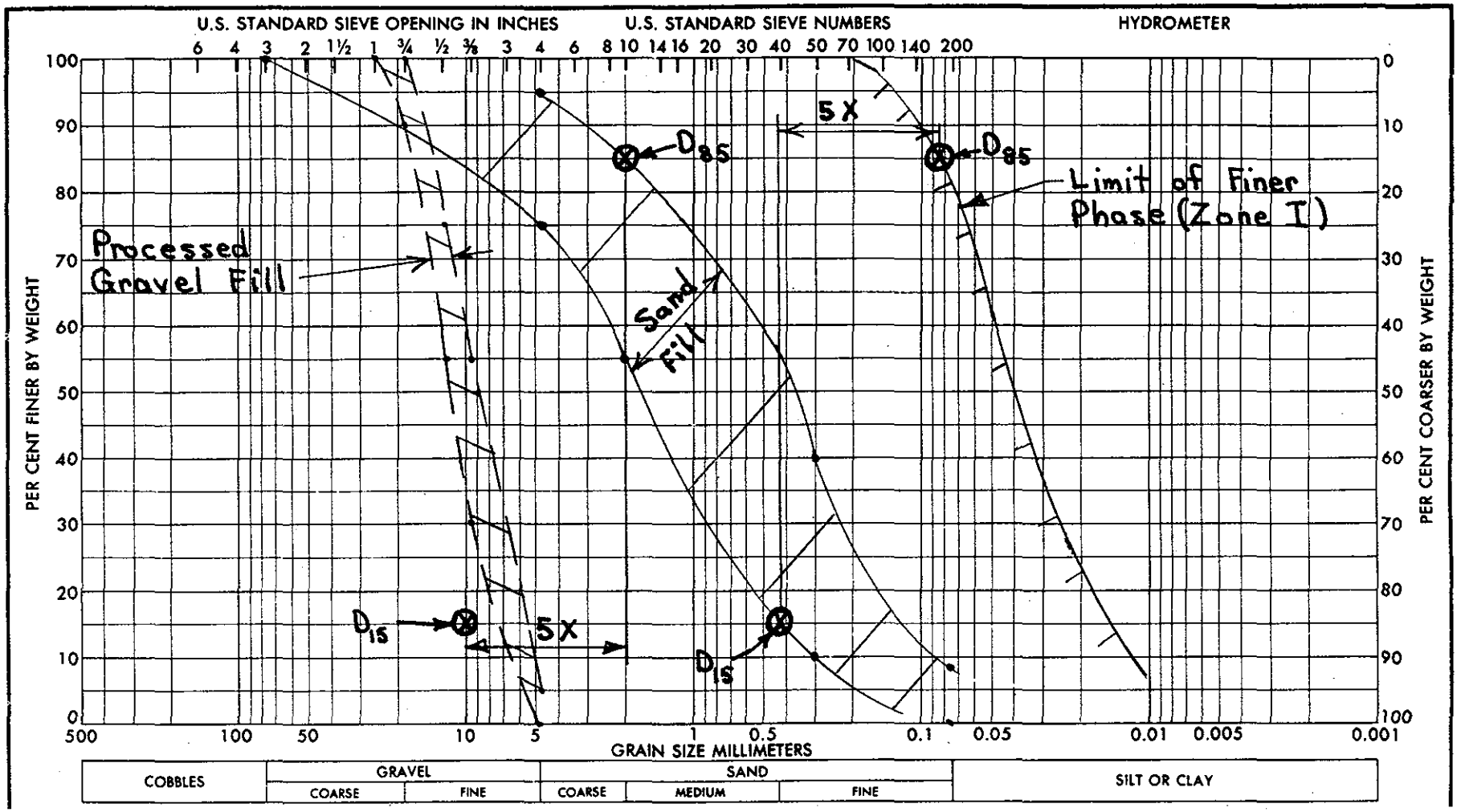
DERBY LOCAL PROTECTION
GRADATION SPECIFICATIONS
GRAVEL FILL AND SAND FILL MATERIALS

PLATE NO. 4-16



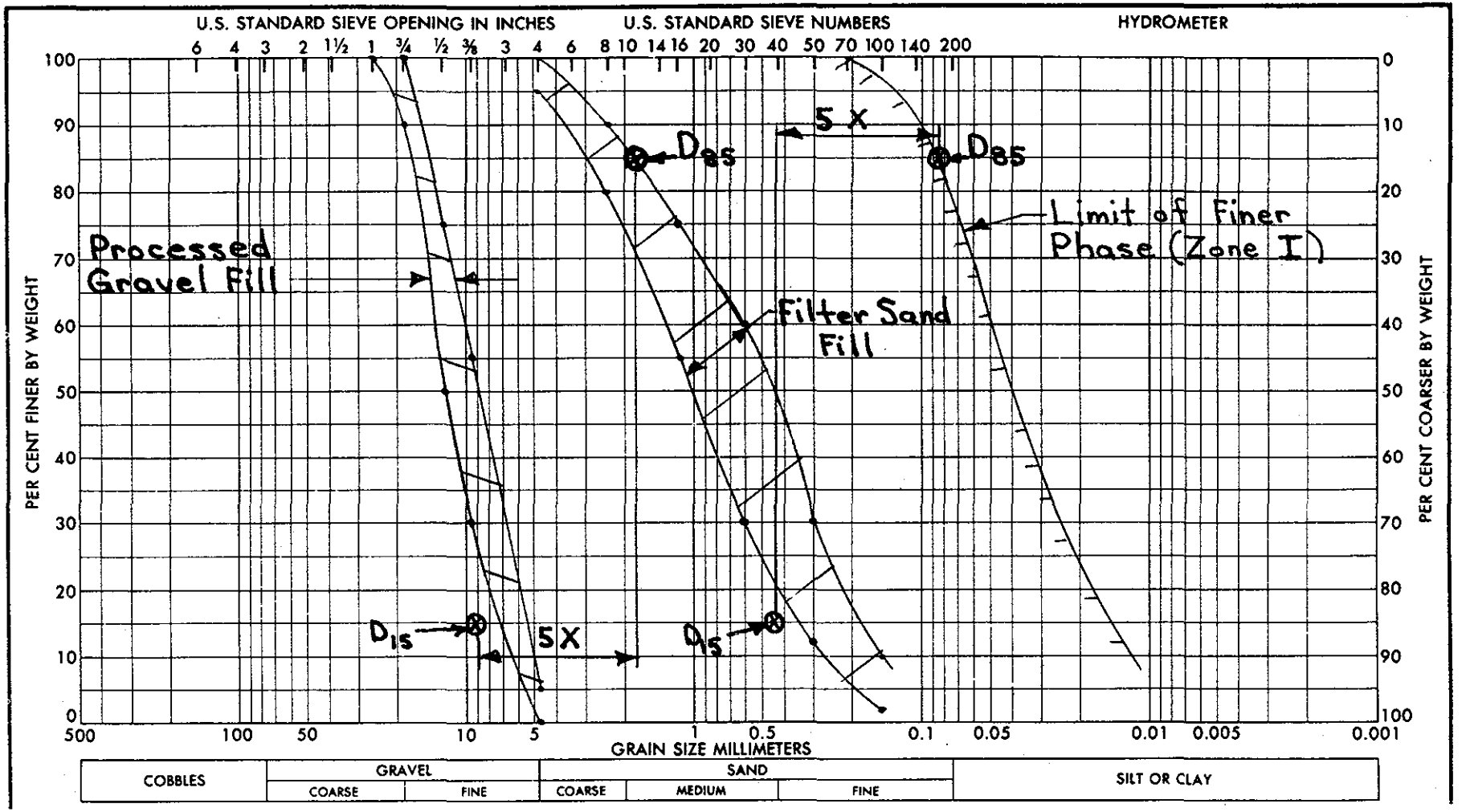
FILTER DESIGN - HOUSATONIC DIKE

PLATE NO. 4-17



FILTER DESIGN - NAUGATUCK DIKE

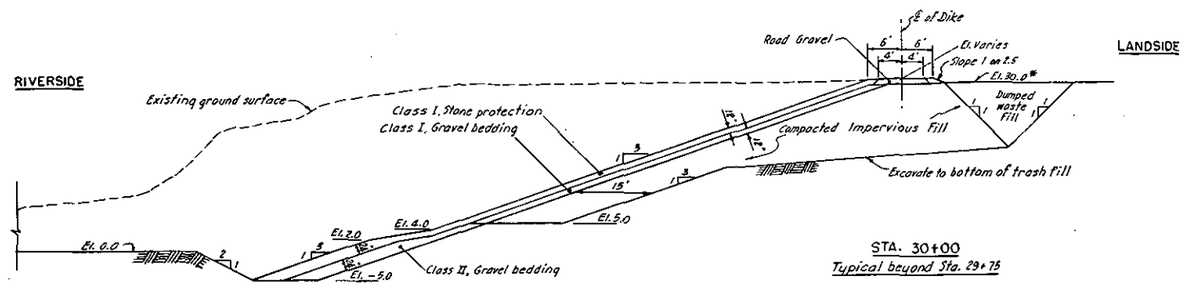
PLATE NO. 4-18



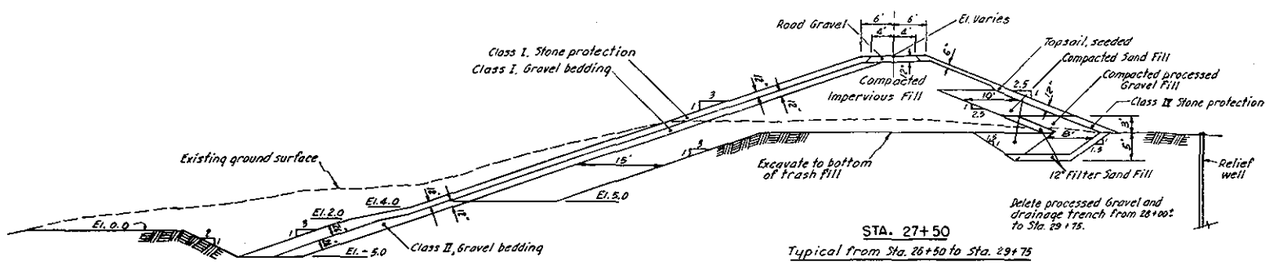
FILTER DESIGN - NAUGATUCK DIKE

PLATE NO. 4-19

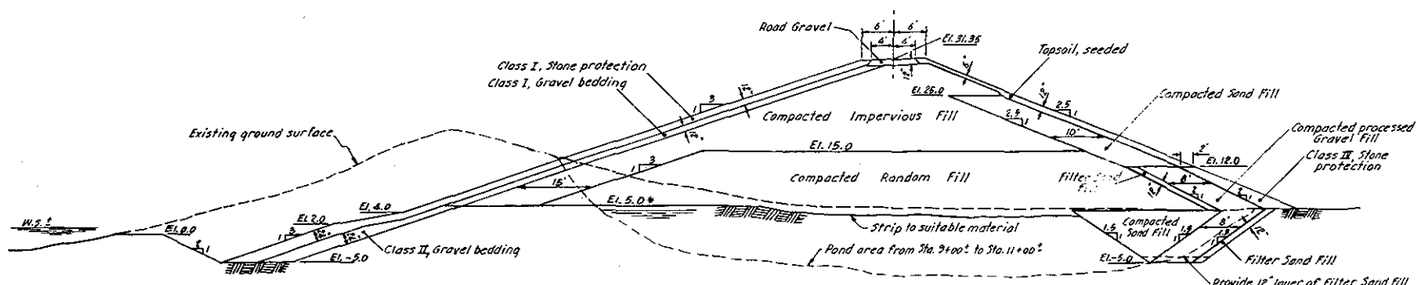
CORPS OF ENGINEERS — U. S. ARMY



STA. 30+00
Typical beyond Sta. 29+75



STA. 27+50
Typical from Sta. 26+50 to Sta. 29+75



STA. 9+00
Typical from Sta. 0+00 to Sta. 26+50

NAUGATUCK RIVER
TYPICAL SECTIONS
SCALE 1" = 10'

NOTES

℄ Ground elevations anticipated at beginning of construction after removal of stockpiles by present owners. It is estimated that these elevations will be as follows.

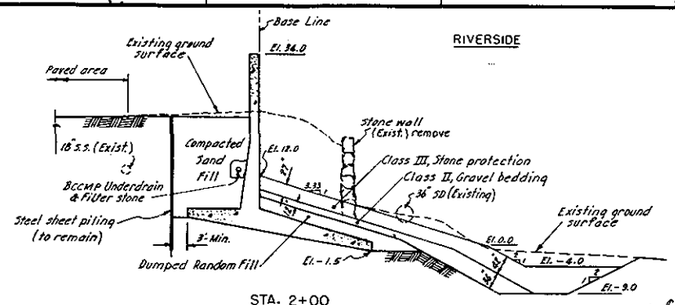
Station	Elevation
0+00 to 25+00	5.0
26+00	10.0
30+00	30.0

GRAPHIC SCALE
1" = 10' 10' 0 10' 20'

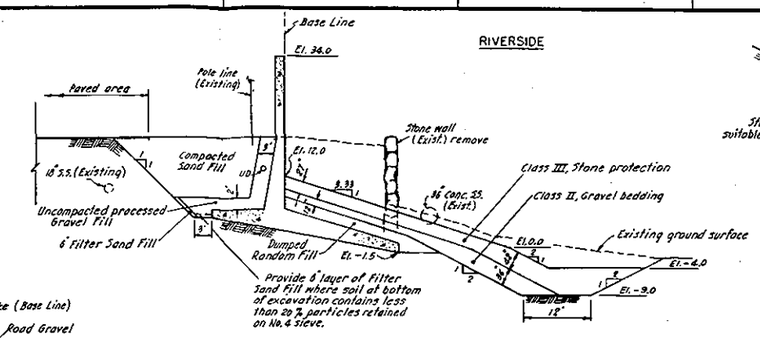
HOUSATONIC RIVER FLOOD CONTROL
DERBY LOCAL PROTECTION
NAUGATUCK DIKE
TYPICAL EMBANKMENT SECTIONS
HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-20

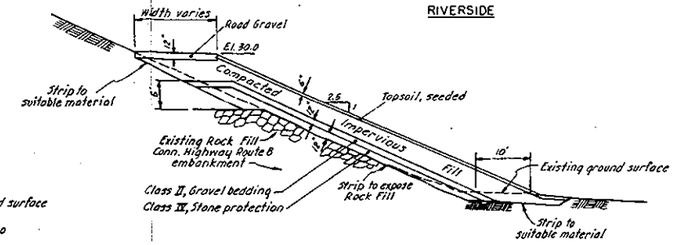
CORPS OF ENGINEERS — U. S. ARMY



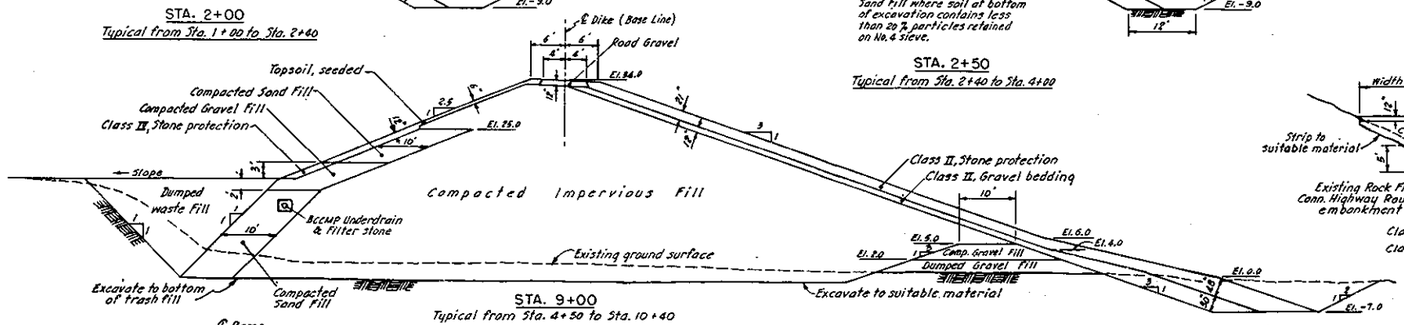
STA. 2+00
Typical from Sta. 1+00 to Sta. 2+40



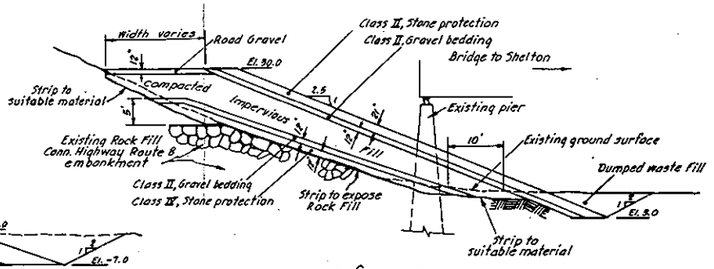
STA. 2+50
Typical from Sta. 2+40 to Sta. 4+00



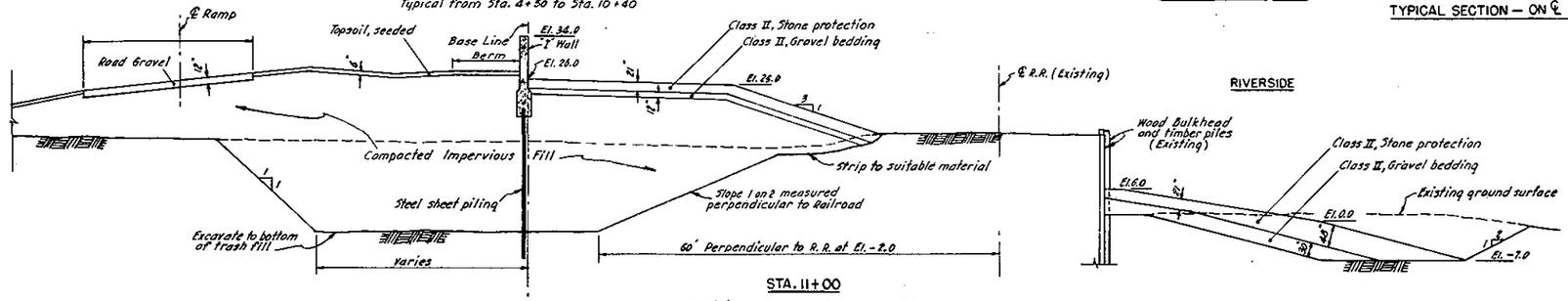
TYPICAL SECTION — EAST SLOPE ROUTE NO. 8



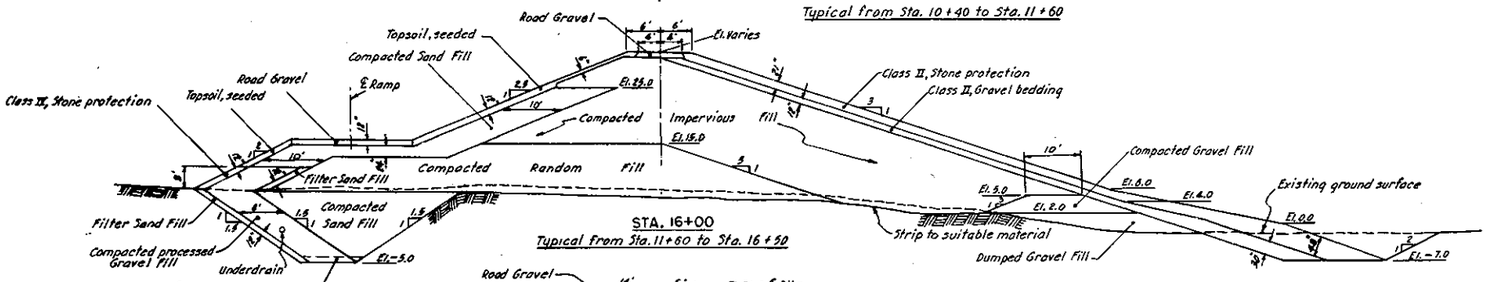
STA. 9+00
Typical from Sta. 4+50 to Sta. 10+40



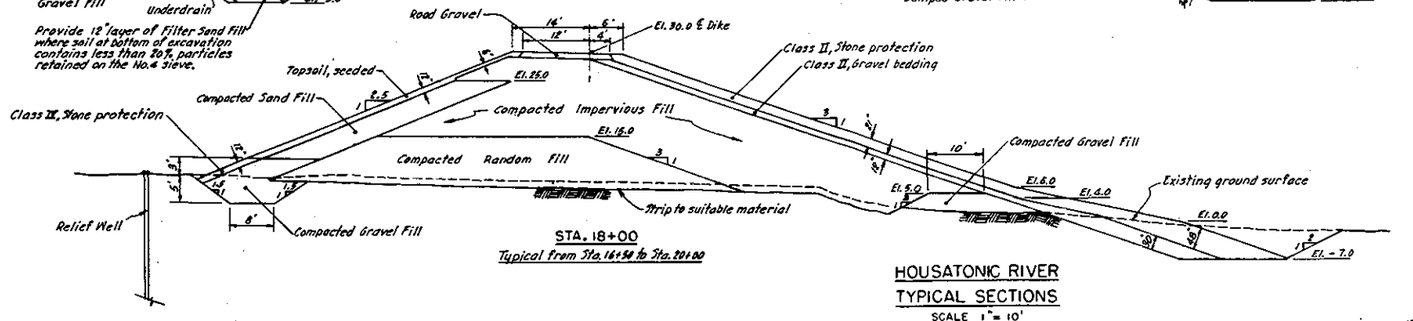
TYPICAL SECTION — ON ℄ ROUTE NO. 8



STA. 11+00
Typical from Sta. 10+40 to Sta. 11+60



STA. 16+00
Typical from Sta. 11+60 to Sta. 16+50



STA. 18+00
Typical from Sta. 16+50 to Sta. 20+00

HOUSATONIC RIVER
TYPICAL SECTIONS
SCALE 1" = 10'

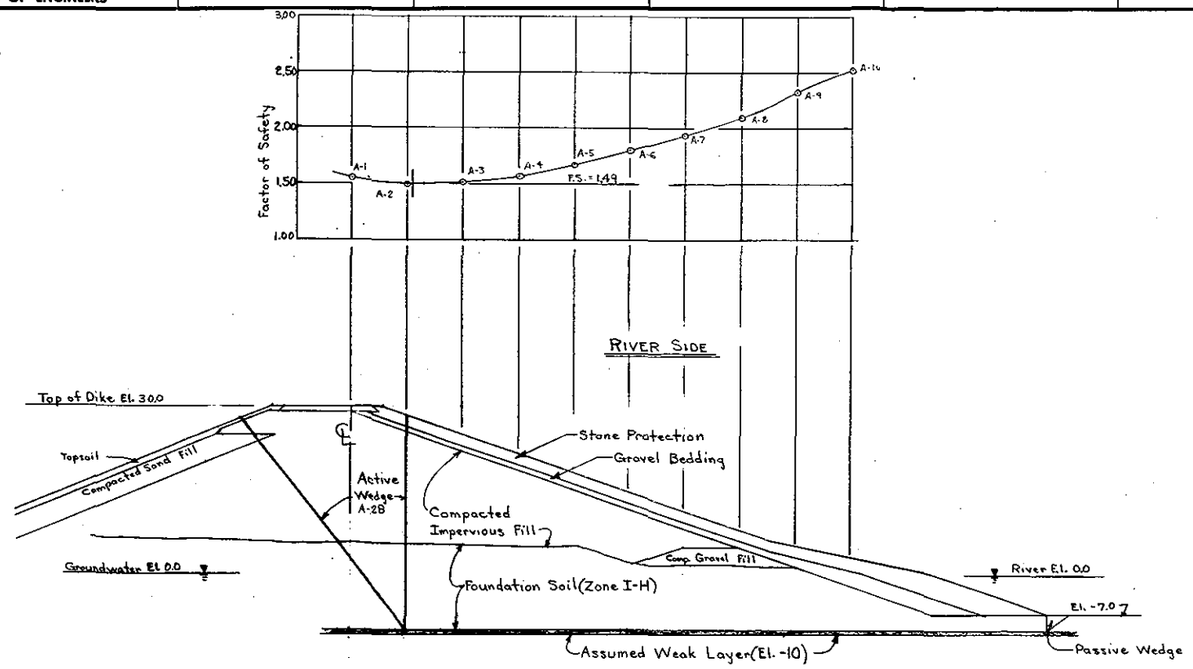
NOTES

GRAPHIC SCALE
1" = 10' 0 10' 20'

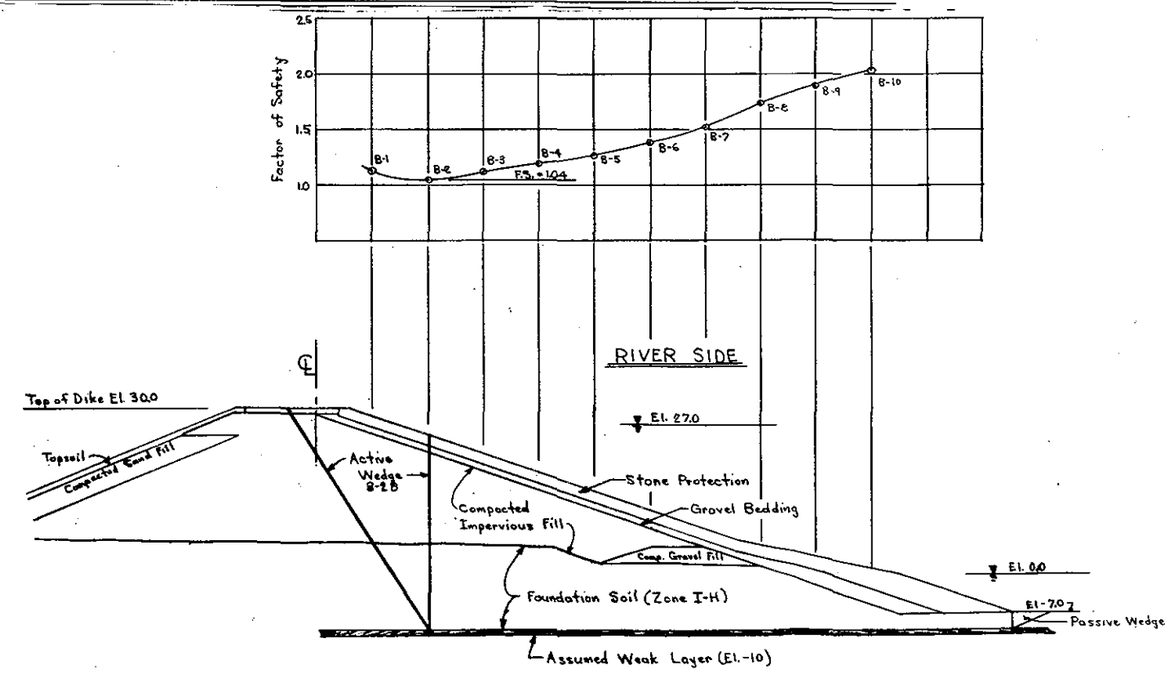
HOUSATONIC RIVER FLOOD CONTROL
DERBY LOCAL PROTECTION
HOUSATONIC DIKE
TYPICAL EMBANKMENT SECTIONS
HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-21

CORPS OF ENGINEERS — U. S. ARMY



END OF CONSTRUCTION CONDITION ANALYSIS - STA. 18+00 - HOUSATONIC DIKE



SUDDEN DRAWDOWN ANALYSIS FROM EL. +27.0 TO EL. 0.0 - STA. 18+00 - HOUSATONIC DIKE

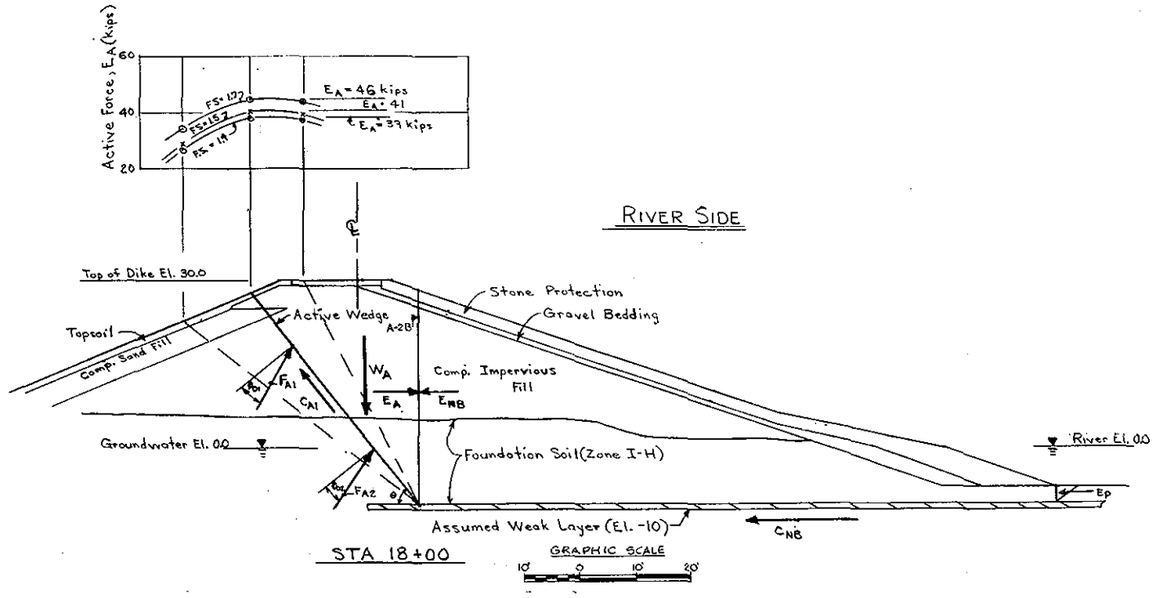
Note
Stability Analyses made in accordance with the following reference: DRAFT EM-1110-2-1902, Feb. 1968

GRAPHIC SCALE
80' 0 80' 160'

HOUSATONIC RIVER FLOOD CONTROL
DERBY LOCAL PROTECTION
HOUSATONIC DIKE
SUMMARY OF STABILITY ANALYSES
HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-22

CORPS OF ENGINEERS — U. S. ARMY



DESIGN VALUES

MATERIAL	UNIT WEIGHT (PCF) $\gamma_{sat.}$	γ_{Moist}	γ_{Dry}	$\gamma_{sub.}$	SHEAR STRENGTHS S,R,Q ϕ	C, T.S.F.
Stone Protection	140	—	120	78	35	0
Comp. Gravel Fill, Sand Fill	145	140	130	83	30	0
Comp. Impervious + Random Fills	140	130	120	78	30	0.2
Foundation Soil (Zone I-H) Sta. 16+90 to Sta. 21+00	120	100	90	58	25	0
Assumed Weak Layer	—	—	—	—	0	0.25
Gravel Bedding, Dumped Gravel	145	140	130	83	30	0

ACTIVE WEDGE 2B - WEIGHT AND COHESION VECTORS

Material	Symbol	Area (ft^2) × Unit Weight (pcf) × Conversion Factor		Weight (kips)
Impervious	W_1 (moist)	221 ft^2 × 130 $\frac{lbs}{ft^3}$ × $\frac{1\ kips}{1000\ lbs}$	=	28.7 kips
		Weight for Volume ①	=	28.7
Impervious	W_2 (moist)	282.5 × 130 $\frac{lbs}{ft^3}$ × $\frac{1\ kips}{1000\ lbs}$	=	36.8 kips
Stone Protection	W_3 (dry)	13.0 × 120 " × $\frac{1}{1000}$ "	=	1.6 "
Gravel Bedding	W_4 (dry)	9.5 × 130 " × $\frac{1}{1000}$ "	=	1.2 "
Foundation Soil	W_5 (moist)	53.4 × 100 " × $\frac{1}{1000}$ "	=	5.3 "
Foundation Soil	W_6 (sub.)	40.0 × 58 " × $\frac{1}{1000}$ "	=	2.3 "
		Weight for Volume ②	=	47.2 kips

Cohesion

$C_A = 0.2 \frac{tons}{ft^2} \times 2000\ lbs \times \frac{1\ kips}{1000\ lbs} = 0.4\ kips/ft^2$; $C_A L = \frac{0.8}{1.5} \times 289\ ft. = 7.6$ kips

PASSIVE PRESSURE (E_P)

E_P (toe) Trial F.S. = 1.5

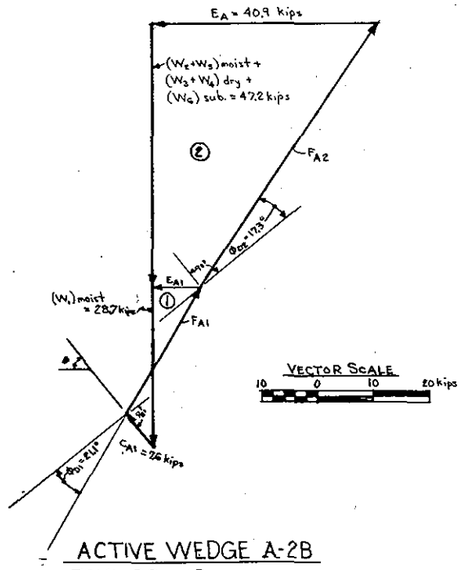
$= \frac{\gamma_{(sub)} h^2}{2} (\tan^2 45° + \phi_{D/2})$

$= \frac{58\ lbs \times (3)^2\ ft^2}{ft^3 \quad 2} (\tan^2 45° + \frac{17.5}{2}) \times \frac{1\ kips}{1000\ lbs} = 0.98$ kips

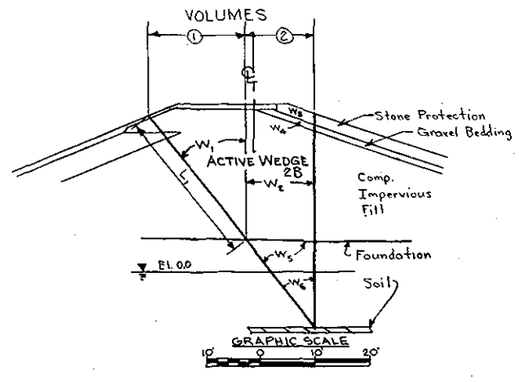
NEUTRAL BLOCK - COHESION VECTOR

$c = 0.25 \frac{tons}{ft^2} \times 2{,}000\ lbs \times \frac{1\ kips}{ton\ 1000\ lbs} = 0.5 \frac{kips}{ft^2}$

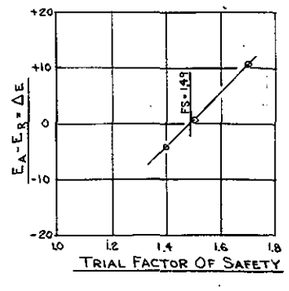
$C_D L = \frac{0.5\ kips}{1.5\ ft^2} \times 116\ ft^2 = 38.7$ kips



ACTIVE WEDGE A-2B
TRIAL F.S. = 1.5



F.S.	$E_P + E_{NB} = E_R$	$E_{A(MAX)}$	$E_A - E_R = \Delta E$
1.4	0.50 + 42.6 = 43.1	39.0	- 4.1
1.5	0.48 + 38.7 = 39.2	41.0	+ 1.8
1.7	0.45 + 34.1 = 34.6	46.0	+ 11.4



HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

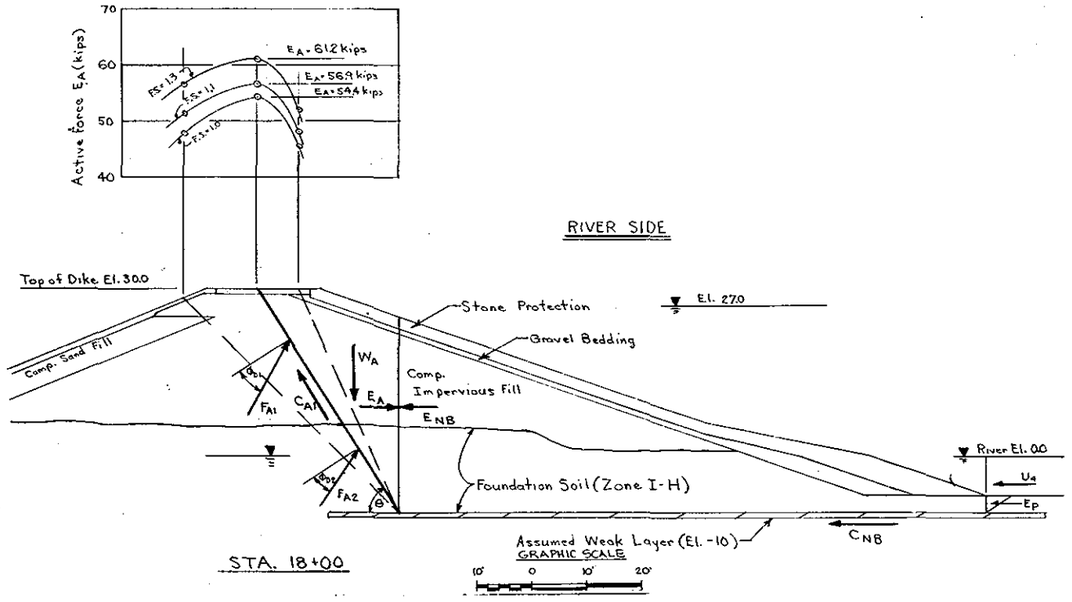
HOUSATONIC DIKE

TYPICAL WEDGE ANALYSIS
END OF CONSTRUCTION CONDITION-
WEDGE A-2B

HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-23

CORPS OF ENGINEERS — U. S. ARMY



DESIGN VALUES

MATERIAL	UNIT WEIGHT (PCF) $\gamma_{Sat.}$	γ_{Moist}	γ_{Dry}	$\gamma_{Sub.}$	SHEAR STRENGTHS S,R,Q ϕ	C, T.S.F.
Stone Protection	140	—	120	78	35	0
Comp. Gravel Fills & Sand Fills	145	140	130	83	30	0
Comp. Impervious & Random Fills	140	130	120	78	30	0.2
Foundation Soil (Zone I-H) Sta. 16+00 to Sta. 21+00	120	100	90	58	25	0
Assumed Weak Layer	—	—	—	—	0°	0.25
Gravel Bedding, Dumped Gravel	145	140	130	83	30	0

Material	Symbol	Area (Ft²)	Unit Wt. (pcf)	Conversion Factor	Weight (Kips)	Symbol	Area (Ft²)	Unit Weight (pcf)	Conversion Factor	Weight (Kips)
Stone Protection	W_1 (dry)	120	120	1 kip / 1000 lbs	1.4	→ W_1 (dry)				1.4
Gravel Bedding	W_2 (moist)	8.6	140	1/1000	0.8	→ W_2 (moist)				0.8
Gravel Bedding	W_3 (sub.)	3.1	83	1/1000	0.3	→ W_3 (moist)	8.1	130	1/1000	4.0
Gravel	W_4 (moist)	9.1	140	1/1000	1.3	→ W_4 (moist)				1.3
Impervious	W_5 (moist)	14.5	130	1/1000	1.9	→ W_5 (moist)				1.9
Impervious	W_6 (sub.)	1450	78	1/1000	11.3	→ W_6 (Sat.)	1450	140	1/1000	20.3
Effective Weight Before Drawdown, Wt. ① = 17.0 kips						Total Wt. Above Lowered Pool, Sub. Wt. Below = 29.7 kips				
Rock Protection	W_7 (dry)	3.0	120	1/1000	0.4	→ W_7 (dry)				0.4 kips
Rock Protection	W_8 (sub.)	17.5	78	1/1000	1.4	→ W_8 (dry)	17.5	120	1/1000	2.1
Gravel Bedding	W_9 (sub)	120	83	1/1000	0.8	→ W_9 (moist)	100	140	1/1000	1.4
Impervious Fill	W_{10} (sub.)	1855	78	1/1000	14.5	→ W_{10} (sat.)	1855	140	1/1000	25.7
Foundation Soil	W_{11} (sub.)	440	58	1/1000	2.6	→ W_{11} (sat.)	44.0	120	1/1000	5.3
Foundation Soil	W_{12} (sub)	305	58	1/1000	1.8	→ W_{12} (sub)				1.8
Effective Wt. Before Drawdown, Volume ② = 21.3 kips						Total Wt. Above Lowered Pool, Sub. Wt. Below = 36.7 kips				

Cohesion

$C_{A1} = 0.2 \frac{tons}{ft^2} \times 2{,}000 \frac{lbs}{ton} \times \frac{1 kips}{1000 lbs} = 0.4 kips/ft^2$; $C_{D1} L_1 = \frac{0.4}{1.1} \times 29 ft. = 10.6 kips$

PASSIVE PRESSURE (E_p)

E_p (toe) Trial F.S. = 1.1

$= \frac{\gamma_{sub.} h^2 (\tan^2 45° + \frac{\phi_D}{2})}{2}$

$- \frac{58 lbs/ft^3 (3 ft)^2 (\tan^2 (45° + \frac{\phi_D}{2}))}{2} \times \frac{1 kip}{1000 lbs} = 0.60 kips$

HYDROSTATIC FORCE (U_s)

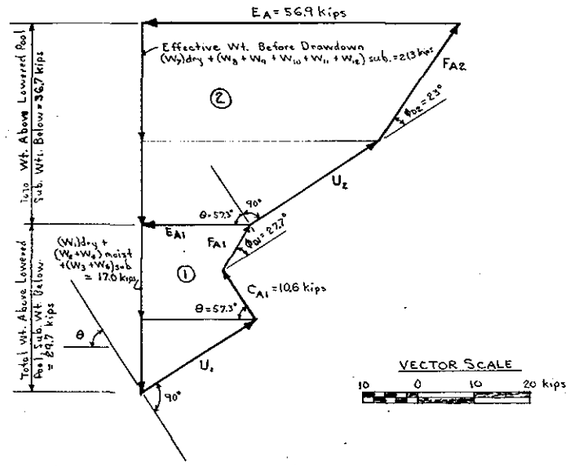
U_s (toe) $= \frac{\gamma_w h^2}{2}$

$= \frac{62.4 (10)^2 ft^2}{2} \times \frac{1 kip}{1000 lbs} = 3.1 kips$

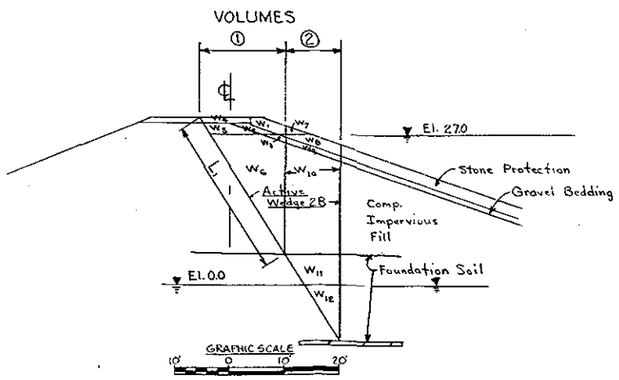
NEUTRAL BLOCK - COHESION VECTOR

$c = 0.25 \frac{tons}{ft^2} \times 2000 \frac{lbs}{ton} \times \frac{1 kip}{1000 lbs} = 0.5 kips/ft^2$

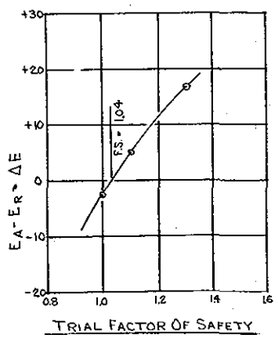
$C_D L = \frac{0.5 kips}{1.1 ft^2} \times 106 ft. = 48.2 kips$



ACTIVE WEDGE B-2B
TRIAL F.S. = 1.1



F.S.	E_p	$E_{NB} + U_s$	E_R	E_A (Max)	$E_A - E_R = \Delta E$
1.0	0.64	+ 53.0 + 3.1 =	56.8	54.4	− 2.4
1.1	0.60	+ 48.2 + 3.1 =	51.9	56.9	+ 5.0
1.3	0.53	+ 40.7 + 3.1 =	44.9	61.2	+ 16.3



HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

HOUSATONIC DIKE

TYPICAL WEDGE ANALYSIS

SUDDEN DRAWDOWN - WEDGE B-2B

HOUSATONIC AND NAUGATUCK RIVERS CONNECTICUT

PLATE NO. 4-24

MATERIALS USAGE CHART

TABLE NO. 1 - EXCAVATION

ITEM	TOTAL QUANTITY (C.Y.)	DISPOSITION	EXCAVATED QUANTITY (C.Y.)	BALANCE FACTOR	EMBANKMENT QUANTITY (C.Y.)	MATERIAL DESIGNATION
EARTH EXCAVATION						
1. Naugatuck Dike						
a. Sta. 0+00 to 29+00 = 56,000 b. Sta. 29+00 to End = 12,000	287,000	To dikes and floodwalls	105,000	.08	84,000	Random Fill
2. Housatonic Dike		To waste and spoil	82,000	—	82,000	Spoil, Waste Fill
a. Sta. 1+00 to 3+95 = 9,000 b. Sta. 3+95 to R.R. Gate #3 = 0 c. RR Gate #3 to Sta. 20+00 = 6,000 d. RR Gates #1, #2, #3 and Pumping Station = 22,000		To topsoil and spoil	100,000	—	100,000	Stripping
3. Unsuitable Material (Spoil) = 82,000						
4. Stripping = 100,000						

MATERIALS USAGE CHART

TABLE NO. 2 - FILL

ITEM	FILL QUANTITY (C.Y.)	SOURCE	TOTAL QUANTITY (C.Y.)
Random Fill	84,000	Earth Excavation	84,000
Impervious Fill	260,000	Contractor Furnished	260,000
Gravel Fill	10,000	Contractor Furnished	10,000
Processed Gravel Fill	14,000	Contractor Furnished	14,000
Sand Fill	38,000	Contractor Furnished	38,000
Filter Sand Fill	4,000	Contractor Furnished	4,000
Class I Gravel Bedding	8,000	Contractor Furnished	8,000
Class II Gravel Bedding	17,000	Contractor Furnished	17,000
Road Gravel	1,000	Contractor Furnished	1,000
Topsoil	8,000	Stripping	8,000
Class I Stone Protection	17,000	Contractor Furnished	17,000
Class II Stone Protection	27,000	Contractor Furnished	27,000
Class III Stone Protection	2,000	Contractor Furnished	2,000
Class IV Stone Protection	1,000	Contractor Furnished	1,000

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

MATERIAL USAGE CHART

(PRELIMINARY)

HOUSATONIC & NAUGATUCK R. CONNECTICUT

PLATE NO. 4-25

APPENDIX A

SUMMARY OF LABORATORY TEST RESULTS

DERBY LOCAL PROTECTION

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
FD-1	5±	B-7	5.0-10.0	GP	75	23	2	0.6													
		B-11	15.0-20.0	SP	0	96	4	0.11													
		B-15	25.0-29.1	SM	0	86	14														
		J-18	30.0-35.0	ML	0	20	80	0.013	NP	NP											
FD-2	4±	B-10	10.0-15.0	SP	46	50	4	0.18													
		J-14R	25.0-30.0	ML	0	23	77	0.023													
		J-16R	30.0-33.7	SM	7	69	24	0.040													
FD-3	16.1±	B-11	20.0-25.0	GP	51	45	4	0.02													
		J-15	37.0-42.0	SW-SM	5	86	9	0.086													
FD-4	17.6±	J-3	3.6- 5.0	SP-SM	18	71	11	0.07													
		J-6	15.0-17.7	SP	48	48	4	0.15													
		J-11	30.0-32.6	GP-GM	48	44	8	0.11													
FD-5	15.4	J-6	20.0-25.0	GP	64	32	4	0.2													
		J-9	32.4-35.0	SP-SM	4	89	7	0.1													
FD-6	15.8	J-7	20.0-25.0	GP-GM	49	44	7	0.13													
		J-10	30.6-35.0	SM	29	58	13	0.048													
FD-7	15.7	J-6	20.0-25.0	SP-SM	34	58	8	0.09													
FD-8	23.8	J-3	6.4- 8.0	SP	47	50	3	0.19													
		J-5	10.0-15.0	SP	43	53	4	0.19													
		J-10	30.0-35.0	GW	63	34	3	0.24													
		J-12	40.0-45.0	SW-SM	2	90	8	0.09													

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

DERBY LOCAL PROTECTION

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	- NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU.FT	* PVD LBS/CU FT	TOTAL	- NO4	SHEAR	CONSOL.	PERM.	
FD-9	20	J-4	10.0-15.0	GP	59	39	2	0.29														
		J-5	15.0-20.0	SP	36	63	1	0.26														
		J-9	25.9-30.0	SP	0	95	5	0.1														
FD-10	8.7	J-6	15.0-17.3	SP	17	79	4	0.17														
		J-9	25.0-30.0	GP	62	36	2	0.25														
FD-11	8.9	J-9	20.0-23.7	GP	60	36	4	0.19														
		J-12	27.6-30.0	SM	0	73	27	0.044														
		J-13	30.0-35.0	SM	0	61	39	0.044														
		J-15	35.0-40.0	ML	0	44	56	0.032														
FD-12	7.2	J-1	0.0- 5.0	GP-GM	51	43	6	0.12														
		J-4	12.5-15.0	ML	0	46	54	0.027														
		J-5R	12.5-15.0	ML								31.5	31.5									
		J-10	32.9-35.0	ML	0	32	68	0.012														
FD-13	5.9	J-1	0.0- 5.0	GW	67	31	2	0.390														
		J-3	10.0-15.0	GP	51	48	1	0.19														
		J-5	16.4-20.0	SP-SM	0	92	8	0.088														
		J-8	27.5-30.0	ML	0	24	76	0.019														
		J-9	30.0-35.0	ML	0	16	84	0.009														
FD-14	8.4	J-2	5.0- 7.6	SP	28	68	4	0.11														
		J-4	10.0-15.0	GW	72	27	1	0.5														
		J-5	15.0-18.7	SM	0	61	39	0.035														
		J-7	20.0-21.2	ML	0	25	75	0.009														
		J-8	21.2-25.0	ML	0	14	86	0.011														
		J-9R	21.2-25.0	ML								31.2	31.2									
		J-11R	25.0-30.0	ML								30.4	30.4									
		J-13	30.9-35.0	SP	24	74	2	0.18														

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NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

DERBY LOCAL PROTECTION

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
FD-15	4.5	J-1	0.0- 5.0	SP-SM	33	55	12	0.05+														
		J-4	15.0-17.3	GP	68	31	1	0.40														
		J-7R	20.0-25.0	ML								33.8	33.8									
		J-8	25.0-30.0	ML	0	39	61	0.017														
		J-9R	25.0-30.0	ML								34.9	34.9									
		J-11R	30.0-35.0	ML								27.2	27.2									
FD-16	3.0	J-4	10.0-15.0	GW	66	33	1	0.53														
		J-6	16.9-20.0	ML	0	20	80	0.01														
		J-7	20.0-25.0	SM	0	78	22	0.05														
		J-9R	25.0-30.0	SM								33.4	33.4									
		J-11	32.9-35.0	SM	0	65	35	0.036														
FD-17	7.8	J-1	0.0- 5.0	GP-GM	47	42	11	0.05+														
		J-3	10.0-13.9	GP	64	35	1	0.35														
		J-5	15.0-20.0	ML	0	17	83	0.0065														
		J-6R	15.0-20.0	ML								34.8	34.8									
		J-7	20.0-25.0	SP	0	97	3	0.1														
		J-10R	30.0-35.0	ML								26.6	26.6									
		J-11	35.0-40.0	SM	4	58	38	0.026														
FD-18	10.5	J-6	15.0-20.0	GP	58	40	2	0.31														
		J-9	30.0-35.0	SM	0	77	23	0.054														
		J-10R	30.0-35.0	SM								32.5	32.5									

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NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

DERBY LOCAL PROTECTION

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
FD-19	5.2	J-1	0.0- 5.0	GP	56	42	2	0.20														
		J-3	7.8-10.0	SP	23	73	4	0.15														
		J-4	10.0-15.0	GW	66	32	2	0.33														
		J-5	15.0-17.5	SM	0	62	38	0.035														
		J-7	20.0-25.0	ML	0	82	18	0.011														
		J-9R	25.0-30.0	ML								30.8	30.8									
		J-13R	35.0-40.0	ML								41.0	41.0									
FD-20	10.1	J-4	10.0-15.0	GP	63	35	2	0.29														
		J-8	25.0-30.0	ML	0	37	63	0.02														
		J-9R	25.0-30.0	ML								30.1	30.1									
		J-11R	30.0-35.0	ML								28.2	28.2									
FD-21	7.9	J-6	15.0-20.0	GP	61	35	4	0.20														
		J-10	35.0-40.0	GP	63	34	3	0.3														
FD-22	31.0	J-10	35.0-40.0	GW	66	31	3	0.32														
FD-23	7.2	J-5	15.0-20.0	SW-SM	29	64	7	0.1														
		J-7	21.7-25.0	SM	0	53	47	0.029														
FD-24	7.8	J-2	5.0-10.0	GP	56	42	2	0.35														
		J-5	15.0-19.4	SP-SM	0	90	10	0.07														
		J-7	20.0-24.2	SM	0	84	16	0.049														
		J-8R	20.0-24.2	SM								23.3	23.3									
		J-10	25.0-30.0	ML	0	12	88	0.008														
		J-11R	25.0-30.0	ML								39.5	39.5									
		J-14	32.0-35.0	SM	0	65	35	0.016														

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* PROVIDENCE VIBRATED DENSITY TEST

DERBY LOCAL PROTECTION

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	- NO 4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	- NO 4	SHEAR	CONSOL.	PERM.	
FD-25	7.3+	J-4	10.0-15.0	GP	60	36	4	0.19														
		J-7	20.0-25.0	ML	0	40	60	0.026														
		J-8R	20.0-25.0	ML								27.1	27.1									
		J-10R	25.0-30.0	ML								27.6	27.6									
		J-12R	30.0-35.0	ML								34.9	34.9									
FD-26	9.1	J-4	5.0-10.0	SP	36	61	3	0.28														
		J-5	10.0-13.7	GP	58	39	3	0.28														
		J-8R	15.0-20.0	SM								10.5	14.1									
		J-9	20.0-25.0	SP-SM	9	82	9	0.084														
		J-10R	20.0-25.0	SP-SM								17.5	19.2									
		J-12R	25.0-27.5	SM								19.7	20.0									
		J-15	30.0-31.0	SM	0	79	21	0.05														
		J-16	31.0-33.5	SP	44	53	3	0.14														
		J-17	33.5-35.0	SM	0	78	22	0.043														
FD-27	4.6	J-3	5.0-10.0	GP	60	36	4	0.03														
		J-7	20.0-25.0	ML	0	43	57	0.021														
		J-11	30.0-35.0	SM	0	74	26	0.043														
FD-28	10.3	J-5	5.5-10.0	SP-SM	23	68	9	0.086														
		J-7	11.0-15.0	GW	65	33	2	0.36														
		J-9	20.0-25.0	ML	0	24	76	0.011														
		J-10R	20.0-25.0	ML								30.7	30.7									
		J-12R	25.0-30.0	ML								28.9	28.9									
		J-14	30.7-35.0	ML	0	32	68	0.021														
		J-15R	30.7-35.0	ML								28.6	28.6									
		J-17R	35.0-40.0	ML								31.1	31.1									

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SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
FD-29	36.2	J-2	5.0-10.0	SM	4	80	16															
		J-6	20.0-25.0	SP-SM	18	71	11															
		J-8	30.0-35.0	SM	0	62	38	0.019	NP	NP												
		J-10	39.0-40.0	GP	52	44	4	0.16														
FD-30	8.7	J-4	6.0- 9.5	SP	7	90	3	0.25														
		J-6	10.0-15.0	GP	52	46	2	0.28														
		J-11	25.0-26.0	SM	4	54	42	0.017														
		J-13	27.0-30.0	ML	0	33	67	0.015														
		J-14	30.0-32.5	ML	0	48	52	0.02														
		J-17	35.0-40.0	SP	0	97	3	0.11														
FD-31	22.5	J-4	10.0-15.0	GP-GM	58	35	7	0.14														
		J-8	25.0-30.0	SW-SM	18	74	8	0.1														
		J-11	35.0-40.0	SP	37	59	4	0.14														
		J-12	40.0-45.0	GP-GM	61	32	7	0.12														
FD-32	35.3	J-1	20.0-25.0	SW-SM	29	60	11	0.065														
		J-9	36.0-37.5	GP	56	42	2	0.32														
		J-11	40.0-45.0	GP	65	34	1	0.50														
FD-33	20.2	J-5	10.0-15.0	SP	10	90	0	0.26														
		J-8	20.0-21.1	SM	0	87	13	0.05														
		J-9	21.1-25.0	SP-SM	30	59	11	0.065														
		J-12	35.0-40.0	GP	57	40	3	0.25														
FD-34	15.0	J-4	16.0-20.0	SP	44	54	2	0.23														
		J-8	25.0-30.0	ML	1	30	69	0.011														

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SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
FD-35	18.0	J-2	5.0- 7.4	SM	22	46	32															
		J-4	10.0-15.0	SM	0	52	48															
		J-5	15.0-17.0	SM	0	74	26	0.03														
		J-7	20.0-25.0	GP	58	38	4	0.2														
		J-9	30.0-32.0	GW	67	31	2	0.29														
		J-10	33.0-35.0	SW-SM	0	93	7	0.091														
FD-36	52.7	J-2	45.0-48.0	GP	80	17	3	0.35														
		J-4	50.0-53.5	SM	0	83	17	0.04														
		J-7	55.0-60.0	GP	57	40	3	0.23														
FD-37	18.4	J-3	5.0-10.0	SP	47	51	2	0.31														
		J-6	15.0-18.0	SM	0	57	43	0.013	NP	NP												
		J-8	20.0-23.4	SP	0	96	4	0.14														
		J-10	25.0-30.0	GP	58	40	2	0.25														
		J-11	30.0-35.0	GP-GM	50	40	10	0.07														
FD-38	32.2	J-2	5.0-10.0	SP-SM	33	60	7	0.10														
		J-3	10.0-15.0	SP-SM	24	66	10	0.070														
		J-5	20.0-25.0	SP-SM	27	61	12	0.063														
		J-8	45.0-50.0	GP-GM	55	39	6	0.16														
FD-39	32.7	J-4R	27.7-30.0	ML									22.2									
		J-7	35.0-40.0	SP	34	64	2	0.21														
FD-40	17.3	J-6	15.0-20.0	SM	0	59	41	0.012														
		J-9	25.0-30.0	GP	60	36	4	0.22														
FD-41	15.0	J-4	7.0- 9.0	OL					NP	NP												
		J-6	10.0-15.0	GP	59	37	4	0.26														
		J-11R	25.0-30.0	SM									28.4									

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SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
FD-42	12.1	J-5	15.0-18.1	SP-SM	22	72	6	0.15														
		J-7	20.0-25.0	SW-SM	34	60	6	0.15														
FD-43	13.4	J-4	15.0-18.7	GP	49	47	4	0.2														
FD-44	12.2	J-5	15.0-20.0	SW	20	76	4	0.18														
FD-45	29.8	J-7	30.0-35.0	SM					NP	NP												
FD-46	2.4	J-2	0.3- 5.0	GP	54	44	2	0.31														
		J-5	10.0-11.3	SP-SM	36	56	8	0.11														
		J-6	11.3-15.0	GP-GM	49	41	10	0.074														
		J-8	16.4-20.0	GP-GM	54	40	6	0.15														
		J-10	21.5-25.0	SP-SM	0	92	8	0.083														
FD-47	0.6	J-2	2.0- 5.0	SP	46	51	3	0.18														
		J-3	5.0-10.0	GP-GM	57	36	7	0.15														
		J-6	15.0-19.5	GP-GM	54	40	6	0.14														
		J-8	20.0-25.0	SP-SM	0	92	8	0.085														
FD-48	6.7	J-18	16.5-20.0	GM	42	35	23	ND														
		J-19	20.0-24.0	SP-SM	40	51	9	0.090														
		J-21	25.0-28.9	SP-SM	0	92	8	0.085														
		J-24	35.0-40.0	SM	0	87	13	0.065														
FD-49	-0.9	J-2	5.0-10.0	GP-GM	54	41	5	0.19														

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SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	- NO4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	- NO4	SHEAR	CONSOL.	PERM.	
FD-50	7.6	J-12	11.0-12.5	SP	24	73	3	0.19														
		J-14	15.0-20.0	SP	47	49	4	0.15														
		J-15	20.0-23.9	SP-SM	10	83	7	0.091														
		J-16	23.9-25.0	GW	63	32	5	0.21														
FD-51	-3.3	J-3	5.0-10.0	GP-GM	47	46	6	0.11														
		J-5	15.0-20.0	SW-SM	15	73	12	0.06														
FD-52	7.0	J-11	9.0-10.5	SP-SM	46	47	7	0.11														
		J-12	11.0-12.2	SP-SM	20	73	7	0.10														
		J-20	20.0-25.0	GP	60	36	4	0.23														
FD-53	30.0	J-3	5.5-10.0	SM	14	61	25	0.020														
		J-8	15.0-17.1	SM	11	62	27	0.022														
		J-10	20.0-25.0	GP-GM	52	41	7	0.130														
		J-13	30.0-35.0	SM	1	83	16	0.050														
FD-54	-0.9	J-6	15.0-16.3	SW-SM	14	77	9	0.085														
		J-7	16.3-20.0	SM	20	57	23															
FD-55	-2.2	J-2	2.5- 5.0	SP	40	56	4	0.13														
		J-4	7.0-10.0	GW-GM	50	41	9	0.090														
		J-6	15.0-20.0	SW	5	94	1	0.25														
		J-8	20.3-25.0	SW-SM	1	91	8	0.11														
FD-56	31.1	J-4	15.0-20.0	SM	15	56	29	0.016														
		J-6	25.0-29.1	SM	7	63	30	0.012														
		J-8	30.0-33.0	SM	26	62	12	0.055														

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SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	- NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	- NO4	SHEAR	CONSOL.	PERM.	
FD-57	-3.9	J-3	5.0- 8.5	SP-SM	34	60	6	0.13														
		J-5	10.0-14.0	GP	55	41	4	0.16														
		J-9	20.7-25.0	GP-GM	48	44	8	0.10														
FD-60	8.0±	J-3	5.7- 6.4	SM	0	74	26	0.017														
		J-12	11.0-12.2	SM	0	82	18	0.047														
		J-14	13.0-13.5	SP	0	97	3	0.210														
		J-19	20.0-25.0	SP-SM	46	47	7	0.110														
FD-61	15.0±	J-6	20.0-25.0	SP	48	48	4	0.2														

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SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STND. AASHO			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{10} m.m.	LL	PL		TOTAL	- NO 4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	- NO 4	SHEAR	CONSOL.	PERM.
FT-1	8.4	B-2	0.7- 7.4	SM	0	80	20	0.038													
		J-1A	0.7- 7.4	SM	1	81	18	0.042													
		J-1B	0.7- 7.4	SP	0	97	3	0.13													
		B-4	7.4-10.0	GW	80	19	1	1.6													
FT-3	7.0±	B-2	2.0- 3.1	GW	71	28	1	0.5													
		B-3	3.1-10.0	GW	77	22	1	0.8													
FT-4	5.0±	B-1	1.5- 3.0	SP	28	69	3	0.18													
		B-2	3.0- 4.5	SP	26	73	1	0.36													
		B-3	4.5- 6.5	GP	67	32	1	0.95													
FT-5	6.0±	B-1	1.0- 3.3	GP	68	31	1	0.5													
		B-2	3.3-11.0	GP	59	40	1	0.36													

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EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	STND. AASHO OPT. WATER % DRY WT	STND. AASHO MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
FA-2	6.5±	J-2	0.8- 5.7	SM	0	63	37	0.021														
FA-3	7.5±	J-2	1.5- 4.5	SM	11	67	22	0.025														
FA-4	9.5±	J-2	1.3- 6.2	SM	0	77	23															
FA-5	8.5±	J-1	0.0- 5.0	SM	6	66	28	0.033														
FA-6	8.5±	J-2	5.4- 6.9	SM	0	64	36	0.023														

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